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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE WASHINGTON MEETING

THE sixty-third meeting of the American Association for the Advancement of Science was held at Washington, D. C., December 27 to December 30, 1911, under the presidency of Dr. Charles E. Bessey, of the University of Nebraska. The meeting was the most successful in the history of the association, both from the point of attendance and from the enthusiasm shown. Beautiful weather prevailed throughout and the people of Washington, including the many scientific men connected with the various governmental bureaus, did everything in their power to make the stay of the visitors pleasant and profitable. The total registration of members of the association was 1,306, whereas the largest previous registration was that at the third Boston meeting, when the total was 1,140. A conservative estimate of the actual number of members of the association present in Washington would place the number at 1,800 and there were doubtless as many as a thousand more present who are members of affiliated societies and not members of the association itself. The following is a list of affiliated and other scientific societies which met in Washington at the same time.

Astronomical and Astrophysical Society of America.
American Physical Society.
American Society of Biological Chemists.
American Chemical Society.
Association of American Geographers.
Geological Society of America.
Paleontological Society of America.
American Association of Economic Entomologists.
Entomological Society of America.
American Breeders' Association.

American Psychological Association.
Southern Society for Philosophy and Psychology.
Botanical Society of America.
American Fern Society.
Society for Horticultural Science.
American Microscopical Society.
American Nature-Study Society.
American Phytopathological Society.
Sullivant Moss Society.
American Anthropological Association.
American Folk-Lore Society.
American Civic Alliance.
American Economic Association.
American Association for Labor Legislation.
American Sociological Society.
American Statistical Association.
American Home Economic Association.
American Physiological Association.
Society of American Bacteriologists.
American Federation of Teachers of the Mathematical and Natural Sciences.
Sigma Xi.

The opening reception to members of the association and affiliated and visiting societies was given at the new National Museum from 8 to 9 P. M. of December 27. At the close of the reception, the association held its first general meeting in the assembly hall of the new National Museum. The meeting was called to order by the retiring president, Dr. A. A. Michelson, who introduced the president-elect, Dr. Charles E. Bessey, who in turn introduced the President of the United States, William H. Taft, who delivered the following address of welcome:

I had a Christmas present a day or two ago. It was a new Encyclopædia Britannica. On the first page of it—I suppose that was the reason why I got it—there was a dedication to King George V. and William Howard Taft, president of the United States. Standing as I do in the presence of this live encyclopedia of all knowledge, I have the same feeling of awe now that I had when I saw that name before all the knowledge of the world. At first I thought somebody else ought to speak before me, but I am glad to come first, because as a welcomer it is not necessary for me to advance a single scientific proposition. I am here only as the Mayor of Washington to advise you that you have the freedom of the city and that it is a beautiful city which you can not stay too long in. Indeed the longer you stay, the longer you want to stay.

We have centers of science here. We have the Carnegie Foundation for Scientific Research, and one of these days I am going to read the things that come from that research, when I have plenty of time. Then, we have a number of bureaus that I presume would be called bureaus of applied science. I don't refer to the science of government—that is altogether too inexact a science for an assembly like this—but I mean there are certain bureaus connected with this government that I hope present matters of interest to so learned and scientific a body as this. There are some of them that I would like to get my hands on and change, but there are limitations upon the power of the president of the United States and he can not do everything he would like. If I could change the Naval Observatory into a bureau, with a scientific professor at the head of it, I would do it to-morrow, but there are conservative gentlemen connected with the coordinate branches of the government that prevent.

Then, we have the Geological Survey and the Bureau of Chemistry and the Bureau of Entomology and the Bureau of Standards. I have no doubt there is a much longer list, which if I had only committed it to memory, I would give here for your studious consideration. But it is enough of a congeries of scientific nerves to justify a meeting of all the scientific bodies of the country here, and I hope that as the government goes on and as congress becomes more liberal, those centers of scientific research, as many of them ought to be, will be improved so as to commend them to those of you who have theories as to what they ought to be under the auspices and with the necessary money which the United States can devote, if it will, to useful scientific research.

There is only one other remark which I wish to make to-night. In thinking over what there was between this audience and me, of any possible common knowledge, it occurred to me it was some experience in the exercise of the judicial faculty—that is in your lives and in your branches of study and action, the search for truth without regard to the result you reach. That is what makes the administration of justice, what makes the work upon the bench so delightful—the absolute indifference to a result, with the weighing of the reasons pro and con and the final solution in accordance with eternal justice. The scientific man in his search for the truth of nature, in

which he could wrest a rule from nature—a law—and in which he studies each individual instance to find that law, or, if he thinks he has found it, to make the instance square with the law, exercises the judicial faculty in a different branch, but with the same necessity for absolute adherence to truth in order that a useful result may be reached—no forcing of a theory, no construction of individual instances in order to make a theory, if those instances really don't fit into it; and if I know the weakness of the scientist or the temptation of a scientist, it is in reference to just such cases as that. Just as the judge upon the bench, with a weakness for deciding a case in advance, because he has heard one or two things in it, and then tries to square everything else that comes along to his original theory, so, too, with you. I have no doubt that what you have to struggle against is too quick recognition of something that leads you to discover a law. Subsequent study changes your mind about it and then you have to go back and build up a new theory or law, slowly, deliberately, but with strict adherence to truth and a desire to find the truth until you finally conquer and reach a conclusion that will bear the test of every instance.

Dr. Walcott, Secretary of the Smithsonian Institution, who was to have given the second address of welcome, was absent through illness.

President Bessey responded to the address of welcome, as follows:

Mr. President:

The members of the American Association for the Advancement of Science feel it to be a great honor to be welcomed to the capital of the country by its foremost citizen, the president of the United States.

In theory at least scientific men are like the men who frequent this city. They are here for a particular purpose. They work for the good of the community. They are not working for their own advancement. They are servants of the people. In all these things we are like the men who occupy legislative, judicial or executive positions in this capital city.

But, Mr. President, you will permit me to suggest, without unseemly egotism, that in the coming of this body of scientific men to the capital, we represent more than an invasion of an equal number of congressmen, judges and executive officers. If I may be allowed to say it, the latter represent present problems and needs, and deal only with the things of immediate importance. *They* are time servers often, or may be mostly in the better sense, but still servers of the present time. And no one will question the usefulness of the man who honestly and conscientiously serves his day and generation—his time.

To the man of science the past, the present, the future, are spread out as the great panorama of nature on which are sketched the successive pictures of an eternity of change and evolution, whose beginning we do not know, and of whose end we have no conception. The politician works wholly in the present and for the present: the scientist's work carries him back through eons of duration to the dawn of eternity, and forward through countless millenniums to a possible twilight time of the universe.

I am not saying that all scientists live in the eternities in this high fashion, nor am I denying that there are great minded statesmen who live in a present which is illumined by the past, and beckoned by the future. No, I would not dare to claim so much for all who enroll in the ranks of science, and certainly we know of some men in public life whose breadth of view on the political questions of the day entitles them to the distinguished name of statesmen.

So I stand here representing a body of men, in some respects like those who are visibly engaged in conducting the government of the country, but in other respects constituting a very different body, and it is on their behalf that I thank you sincerely for the cordial welcome you have extended to us.

But while I speak I am reminded that in these later years you have taken into the service of the government many hundreds of trained scientific men, and that these men by their labors are helping you to solve some of the most difficult problems that the government has had to face. With these men we who assemble here to-day have close ties and cordial sympathies. We remember that although in government service they are still scientific men, and that the problems you have placed before them are scientific problems. And we are anxious, Mr. President, that these brothers of ours shall have full opportunity for doing well the work put before them. We are glad that by the establishment of an enlightened system of laws controlling the civil service this body of scientists has been lifted out of the reach of petty personal politics. That has made it possible for

the government to secure the services of so many men of the highest scientific attainments. It now remains for you, Mr. President, as the executive head over all the scientific bureaus to see that the proper atmosphere is maintained in every bureau, and in every division where scientific men work. It has been hinted sometimes that with all that has been done so well to keep the outside politician away from the scientist's laboratory, we have not wholly succeeded in keeping the inside politician from creating an atmosphere quite inimical to scientific work. For it must be remembered that scientific work is not all a digging out of facts as is so often supposed, but that the best of it calls for comparison, and reflection, and the careful drawing of conclusions, and this takes much time, and mental leisure, and a freedom from petty irritations.

If the men who have to solve the scientific problems of the government are to discharge their duties with the highest efficiency, they must have good appliances in the way of laboratories, experimental stations, apparatus, reference libraries and such other material necessities as pertain to the particular work they have in hand, but more than these, far more I may say, is the necessity for a congenial and sympathetic environment. And rumor has it that this helpful environment is not always present in the splendidly equipped divisions, where it may be that the expert scientist is hampered and distracted by the necessity of making preliminary plans, and preliminary projects, and final plans and final projects, and reports of progress, and preliminary reports, and final reports, and supplementary reports, to officials who neither understand the nature of the problems nor the scientific methods of their study.

We shall agree that these things ought not to be, and I am assured by the interest you have shown in the scientific work of the country at large, and especially by what you have done here in the capital that you will gladly help to free the government scientists from such trammels as may have sometimes hedged them in. In these days when we are applying "scientific management" to business and the industries certainly we ought to have a scientific management of our bureaus of science.

Mr. President, I regard it as a great honor to have had the privilege of responding to the welcome extended to this Association, and doubly so when that welcome has been given by you, whom we all delight to honor, as the president of this good country of ours.

The annual address was then delivered by the retiring president Dr. A. A. Michelson, on "Recent Progress in Spectroscopic Methods," after which the meeting was adjourned.

The addresses by retiring vice-presidents of sections were made as follows:

WEDNESDAY AFTERNOON

Vice-president Frankforter before the Section of Chemistry. Title: The Resins and their Chemical Relations to the Terpenes.

Vice-president Harper before the Section of Botany. Title: Some Current Conceptions of the Germ Plasm.

THURSDAY AFTERNOON

Vice-president Rosa before the Section of Physics. Title: Work of the Electrical Division of the Bureau of Standards.

Vice-president Rotch before the Section of Mechanical Science and Engineering. Title: Aerial Engineering.

Vice-president Hill before the Section of Education. Title: The Teaching of General Courses in Science.

FRIDAY MORNING

Vice-president Moore before the Section of Mathematics and Astronomy. Title: On the Foundation of the Theory of Linear Integral Equations.

FRIDAY AFTERNOON

Vice-president Dixon before the Section of Anthropology and Psychology. Title: The Independence of the Culture of the American Indian.

Vice-president Novy before the Section of Physiology and Experimental Medicine. Title: Carriers of Disease.

Vice-president Burton before the Section of Social and Economic Science. Title: The Cause of High Prices.

Among other addresses which were given and meetings for general discussion which were held, the following may be mentioned:

On Thursday morning, there was a symposium on "The Ether" before the American Physical Society, which was led by Professor A. A. Michelson, who was followed by Professor A. G. Webster and others.

Dr. H. B. Talbot, chairman of the Division of Physical and Inorganic Chemistry, delivered an address on Wednesday afternoon, on the "Privileges and Responsibilities of the Chemical Analyst."

On Thursday evening, the president of the American Chemical Society, Dr. Alexander Smith, addressed the society on the subject, "An Early Physical Chemist." The address was followed by a lecture by Frank B. Kenrick and H. E. Howe, on "Lantern Experiments on Reactions in Heterogeneous Systems."

A symposium on "Drug Assay" was held on Friday morning by the Division of Pharmaceutical Chemistry, and one on "Mineral Wastes and Conservations" was held by the Division of Industrial Chemists and Chemical Engineers.

President R. S. Tarr, of the Association of American Geographers, gave his presidential address on Friday morning, on "The Glaciers and Glaciation of Alaska."

The Paleontological Society of America held a symposium Friday morning, on "Ten Years Progress in Vertebrate Paleontology."

A symposium on " Instinct and Intelligence" was held on Wednesday morning by the American Psychological Association.

The subject of the address of President Franz of the Southern Society for Philosophy and Psychology, given on Thursday afternoon, was "New Phrenology" and that of President Seashore, of the American Psychological Association, given on Thursday evening, was "The Measure of a Singer."

Professor J. H. Comstock addressed the Entomological Society of America on Wednesday evening on "Some Biological Features of Spiders."

The Section of Botany held a symposium on "Soils" on Wednesday afternoon, and the Botanical Society of America held a symposium on Thursday afternoon on "Modern Aspects of Paleobotany" after the retiring president, Dr. E. F. Smith, had delivered his presidential address on "Some Aspects of the Relationship of the Crowngall Disease to Human Cancer."

Dr. H. M. Beldon gave his presidential address, on "Folk Poetry in America," on Thursday morning, before a joint session of Section H and the American Folk-Lore Society. In the afternoon, the joint session was in charge of the American Anthropological Association and a symposium was held on "Environment and Culture."

Presidential addresses by Dr. F. H. Giddings, president of the American Sociological Society, on the "Quality of Civilization" and by Dr. H. W. Farnum, president of the American Economic Association, on "The Economic Utilization of History," were given before a joint meeting of the two societies, on Wednesday evening.

On Friday afternoon at a joint meeting of Section K with the American Physiological Society and the Society of American Bacteriologists a symposium was held on "Acapina and Shock."

The council of the American Association met daily and the following are the chief items of business transacted:

Eighty-seven new members were elected into the association, and the following were elected fellows of the association: Frank H. Bailey, Fred Asa Barnes, John Fritz, A. A. Hammerslog, Truman Michelson, F. Paul Anderson, Gardner Chace Anthony, Henry Sturgis Drinker, Louis Doremus Huntoon, William Christian Hood, Clement Ross Jones, John Price Jackson, James W. Lawrence, Edwin Hoyt Lockwood, Chas. E. Suche, Francis C. Shenehon, Frederick W. Sperr, James T. Beard, Wm. J. Sharwood, Lula Pace, Pliny E. Goddard, George Byron Gordon, Guy M. Whipple, Milo B. Hillegas, Frederick E. Farrington, Harold

A. Wilson, Frank Wenner, F. C. Brown, E. A. Harrington, W. J. Fisher.

The report of the treasurer for 1910 was presented by the permanent secretary and was accepted and ordered placed on file. The financial report of the permanent secretary was presented, accepted and ordered published.

Dr. H. E. Summers was elected secretary *pro tem* of the council.

The following resolutions were adopted:

1. Whereas, the will of the late Jane M. Smith, of Pittsburgh, Pa., a former life member of the American Association for the Advancement of Science, contains the following bequest, namely:

"Seventeenth: I give and bequeath to the National Geographic Society of Washington, D. C., the sum of five thousand dollars ($5,000); to the American Forestry Association of Washington, D. C., the sum of five thousand dollars ($5,000); and to the American Association for the Advancement of Science of Washington, D. C., the sum of five thousand dollars ($5,000). I hereby direct that each of said sums be invested and the net income thereof be used for the purpose of creating life members of said three organizations in cases where worthy and competent persons are not able to pay for such memberships."

Be it therefore *Resolved*, That the permanent secretary of the association be and hereby is authorized to accept from the executors of Jane M. Smith, deceased, the legacy of five thousand dollars ($5,000) bequeathed by her to the American Association for the Advancement of Science as a fund whose income may be used in the payment of life-membership commutations in the association.

Resolved, That this fund be designated as the Jane M. Smith Fund of the American Association for the Advancement of Science.

Resolved, That said sum of five thousand dollars ($5,000) or any instalments thereof as they may be received, be turned over to the treasurer of the association for investment in such manner as the council of the association may direct.

Resolved, That the application of the income of the Jane M. Smith Fund in conformity with the wishes of the testatrix be determined by the council of the association after reference to and recommendations from the committee on policy.

2. Whereas, more than fifty per cent. of the injurious insects and plant diseases of first-class importance in the United States have been imported accidentally or in the course of commerce from other countries; and

Whereas, the United States of America is the only country among the great nations of the world which has no national quarantine or inspection service looking towards the prevention of such introductions:

Therefore be it *Resolved*, That in the opinion of the American Association for the Advancement of Science the passage of a national quarantine and inspection law directed against the introduction and establishment of injurious insects and plant diseases from other parts of the world is a great desideratum at the present time.

The permanent secretary was directed to transmit copies of this resolution to the president of the United States, the president of the senate, the speaker of the house and the chairman of the committee on agriculture of the house of representatives.

3. *Resolved*, That the permanent secretary be instructed to present for nomination to fellowship the names of those members who are members of affiliated societies, which have already been designated as having qualifications for membership equivalent to fellowship in the association.

4. *Resolved*, That the council of the American Association for the Advancement of Science approves the creation of a Bureau of Astronomy with a scientific chief, which shall have charge of the Naval Observatory and of the Nautical Almanac, and respectfully requests that every endeavor be made to put into operation this plan in the interests of astronomy in the United States.

The permanent secretary is requested to forward a copy of this resolution to the president of the United States, to the president of the senate and to the speaker of the house of representatives.

5. *Resolved*, That Section I be given permission to meet at times and places different from those of the general association, whenever the sectional committee and the committee on policy so agree.

6. *Resolved*, That the treasurer of the association be authorized to invest $20,000 of the permanent funds of the association in such interest-bearing securities as the committee on policy of the association may approve.

The council instructed the permanent secretary to publish in February or March next a list of officers and members of the

association. The resignations of N. L. Britton and W. H. Welch from the Committee on Policy were accepted and D. T. MacDougal and W. J. Humphreys were appointed to fill the vacancies.

The council authorized an increase in compensation of the present assistant to the permanent secretary from $100 per month to $125 per month.

A resolution was adopted recommending that future delegates from the association to international conferences and other delegate bodies be requested to submit brief reports to the council.

A report from Dr. Hutton Webster, delegate to the First Races Contest, was read and ordered filed, and the report of Dr. B. Shimek, delegate to the Third National Conservation Congress, was presented and placed on file.

The council resolved that the American Association for the Advancement of Science reaffirms its approval of the establishment of a National Department of Public Health.

Senator Theodore E. Burton, Dr. Wm. Trelease and Dr. Henry B. Ward were elected to fill vacancies in the council.

The following grants were allowed for the ensuing year:

To the Concilium Bibliographicum $200
To Mr. Frank C. Gates, A.B., for an investigation of the relation of transpiration to plant structure in bog plants, in collaboration with Professor T. C. Newcombe $100

The following amendments to the constitution were read as a formal notification in order that they may be acted upon next year under the provisions of the constitution:

Article 31. Substitute for existing article the following:

"The permanent secretary shall publish from time to time a list of officers and members of the association together with such other matter as the council may direct.

Article 3. In closing line omit the word "annual."

Article 6. Omit final sentence.

Article 19. Omit "in the annual volume of Proceedings."

Same article, omit "to the printing and distribution of the annual volume of Proceedings and all other."

Article 22. After "Education" add
"M, Agriculture," or
"M, Agriculture and Forestry," or
"M, Forestry,"
and
"And the council shall have power to create additional sections from time to time when deemed desirable."

Article 22. Lines 4 and 5, change from "H, Anthropology and Psychology" to "H, Anthropology."

Article 22. Abolish Section I.

At a meeting of the general committee held Friday evening, December 29, it was resolved to hold the next meeting at Cleveland, Ohio, the meeting to begin on the Monday of the week in which January first, 1913, falls. It was further resolved to recommend to the next general committee that the meeting for 1913 be held in Atlanta, Georgia. It was further resolved that the committee looks with favor on the plan of holding a summer meeting on the Pacific coast in 1915.

The following officers were elected for the coming year:

President—Dr. Edward C. Pickering, director of the Harvard Astronomical Observatory.

Vice-presidents:

Sec. A—E. B. Van Vleck, University of Wisconsin.
Sec. B—Arthur Gordon Webster, Clark University.
Sec. C—W. Lash Miller, Toronto.
Sec. D—J. A. Holmes, Washington, D. C.
Sec. E—James E. Todd, University of Kansas.
Sec. F—William A. Locy, Northwestern University.
Sec. G—D. S. Johnson, Johns Hopkins University.
Sec. H—J. Walter Fewkes, Washington, D. C.
Sec. I—John Hays Hammond, New York.

Sec. K—J. J. McCleod, Cleveland, Ohio.
Sec. L—J. McKeen Cattell, Columbia University.

Secretaries of Sections:
Sec. B—W. J. Humphreys, Mount Weather, Va.
Sec. E—Geo. F. Kay, University of Iowa.
Sec. K—Waldemar Koch, Chicago University.

General Secretary—H. E. Summers, Iowa State College.

Secretary of the Council—H. W. Springsteen, Western Reserve University.

John Zeleny,
General Secretary

THE WORK OF THE ELECTRICAL DIVISION OF THE BUREAU OF STANDARDS[1]

1. INTRODUCTION

The Bureau of Standards has grown considerably, both in equipment and personnel, since its inception in 1901. The original staff of fourteen has increased to nearly three hundred, and the material equipment has been augmented in a similar ratio. Its functions also have developed, although authority for all its manifold activities is contained in the brief act of Congress of March 3, 1901, which established the Bureau, and its growth has been closely along the lines laid down by the director in his first announcements of the policy of the new bureau.

The name Bureau of Standards does not signify to the average person the wide scope of the work of the bureau, which is really a national physical, chemical and engineering laboratory. In Germany there are three similar national institutions, and the establishment of a fourth has been proposed; these four combined would cover the field occupied in this country by the Bureau of Standards. The German institutions referred to are the Physikalisch-Technische Reichsanstalt, for physics; the Normal Eichungs-Kommission, for weights and measures, and the Material Prufungs Amt, for engineering and the testing of materials. In addition to these three institutions, which have been in active operation for many years, a royal chemical institute for chemistry has been for some time under consideration. In England the National Physical Laboratory occupies a field more nearly like that of the Bureau of Standards, but the Board of Trade divides with it some of these functions.

The work of the Bureau of Standards is distributed among seven divisions, as follows:

I. Electricity and photometry.
II. Weights and measures.
III. Heat and thermometry.
IV. Optics.
V. Chemistry.
VI. and VII. Engineering and the testing of materials.

Thus, it will be seen that the work of Divisions I., III. and IV. correspond to that of the Reichsanstalt of Germany, and the remaining four divisions to the other three German institutions mentioned above.

The work of the bureau may be broadly divided into two parts, research and testing, although much time is devoted to the preparation of specifications, the standardization of practise and the diffusion of information that does not fall under either of these heads. To undertake to describe the work of research, testing and standardization carried on in all the divisions of the bureau would be a task requiring more time than is at present available. I shall, therefore, limit myself to the work of Division I., and if I succeed in bringing to your minds a full appreciation of the character and importance of the work we are trying to do in electricity, magnetism and photometry, you may take this when

[1] Address of the vice-president and chairman of Section B, Washington, 1911.

multiplied by six as standing for the work of the bureau as a whole.

2. SCIENTIFIC INVESTIGATIONS

The scientific researches which have been carried out in the electrical division, the results of which are contained in more than 100 papers published in the *Bulletin* of the bureau, may be grouped under the following five heads.

(*a*) *Theory of Electrical Measurements and of Absolute Instruments.*—One of the first things that demanded attention when the bureau was established was the fixing and maintaining of the standards for electrical measurements, and the choice and development of methods of measurement. This has involved a thorough study of the theory of electrical measurements, and of the theory of the absolute instruments which are employed in the various kinds of absolute electrical measurements. Such studies naturally led to new methods and to the improvement of existing methods, and to a better knowledge of the theory of electrical measurements and of electrical instruments. The *Bulletin* contains twenty-seven papers under this head, including such subjects as the calculation of self and mutual inductance of the various kinds of coils used in the absolute instruments employed in the measurement of resistance and current in C.G.S. units, and in many other kinds of measuring instruments; the theory of different kinds of electrodynamometers, and of a new method for the absolute measurement of resistance; theory of coupled circuits and other problems in wireless telegraphy, and the preparation of a complete list of formulæ for use in calculating inductances of almost every kind of electric circuit.

(*b*) *Methods of Electrical Measurement.*—In the work of electrical testing and research much attention was given to improving methods of measurement, and the *Bulletin* contains thirty-three papers on this subject, including the absolute measurement of inductance and of capacity, the measurement of inductance in terms of capacity by means of alternating currents, wattmeter methods of measuring power, the influence of wave form upon electrical instruments and upon hysteresis losses in iron, the measurement of energy losses in dielectrics, and in iron, a standard method of demagnetizing iron in measurements of magnetic induction, methods of testing transformer iron, measurement of the ratio of transformation and of phase relations in current and potential transformers, quantitative measurements in radio-telegraphic circuits and experiments with high frequency circuits and various papers on methods of measurement in photometry.

(*c*) *Experimental Researches upon Concrete Electrical Standards.*—The results of absolute electrical measurements are preserved by means of concrete electrical standards, and the practical units of electrical measurements as defined and agreed to by international electrical congresses are expressed in terms of concrete electrical standards, and not in terms of the C.G.S. system. The accuracy attainable in absolute measurements and the definiteness of legal values are both limited by the constancy and reproducibility of the concrete standards by means of which they are expressed and preserved. The principal concrete standards are (1) the *mercury column*, the resistance of which defines the international ohm, and the *wire standards* to which values are assigned in terms of the mercury ohms; (2) the *silver voltameter* which defines the international ampere; and (3) the *Weston normal cell*, the concrete standard employed for the measurement of

electromotive forces, and the value of which is fixed in terms of the international ohm and the international ampere. These concrete standards were defined by the Chicago Electrical Congress of 1893. The principal countries of the world did not, however, adopt the Chicago specifications and numerical values unchanged, so that the international uniformity hoped for was not altogether realized. As the precision of electrical measurements increased and there came a demand for greater accuracy in electrical instruments, the old specifications became inadequate, and the differences in numerical values between different countries became more and more annoying. After attention had been drawn at St. Louis in 1904 to the need of a new international conference for the purpose of securing improved specifications for the concrete electrical standards and uniform numerical values for the same, and after a preliminary conference at Charlottenburg in 1905, in which the program for such an international conference was carefully considered, the conference was called by Great Britain, and met in London in October, 1908. Although considerable attention has been given to the subject of absolute electrical measurements and the preparation of the concrete electrical standards in the fifteen years between 1893 and 1908, it was found at the London Conference impossible to formulate complete specifications for the three primary electrical quantities, and impossible to agree upon a satisfactory value for the Weston normal cell, which latter was adopted at London in place of the Clark cell, as the official standard for expressing the value of the international volt. The discussion at the London Conference brought out clearly the inadequacy of a bulky international conference, sitting for a week or ten days once or twice in a generation, as a tribunal for settling wisely such technical questions as are involved in the specifications of electrical standards and fixing the values of the standard cells so that it would satisfy Ohm's law. It was recognized that this law could not be repealed or ignored, even by an international conference, and the best that could be done, therefore, was to choose a provisional value for the Weston cell (1.0184 volts at 20°) and to leave to an International Committee on Electrical Units and Standards, established by the London Conference for the purpose, the task of carrying on the investigations, completing the specifications, and finding a new and more precise value of the standard cell. This committee consisted of fifteen members and five associate members, representing eleven different countries, and during the three years that have elapsed since the London Conference it has encouraged investigations in the direction indicated, and has partly accomplished its task. While the committee as a whole has acted in the matter, the experimental work has been done chiefly by the national standardizing laboratories of England, France, Germany and the United States, and in this work the Bureau of Standards has been active.

It might appear that three years is ample time in which to settle all the questions necessary to the satisfactory completion of the work left undone by the London Conference, and so it would be if a reproducibility of one one-hundredth of one per cent. in the standards were deemed sufficient. But when we recall the constancy of the standards of length and mass, and the regularity of the earth as a standard timepiece, we can not be content with our concrete standards of resistance and electromotive force so long as uncertainties exist as great as a thousandth of one per cent. As the demands for greater

precision of measurement increase, the national standardizing laboratory must maintain so high a plane of excellence that those best qualified to judge have the fullest confidence in its fundamental standards and in the accuracy of its work. The endeavor to improve these standards is not merely a matter of doing patiently the same thing over and over again. It means a whole train of investigations, through which an intimate knowledge of the behavior of these standards is obtained, disturbing influences removed or taken account of, impurities in the materials eliminated, and measurements made with what a few years ago would have seemed almost impossible accuracy. The by-products of such researches are often of great value, and become useful in many other directions.

To illustrate, let me refer to the silver voltameter, the concrete standard of electric current. In 1908 it was believed by many that the chemistry of the Rayleigh voltameter was simple, and that the most recently published work upon it had cleared up a mystery of long standing, relative to the disagreement of the Rayleigh and Richards forms of voltameters. Further study at the Bureau of Standards showed complexities due to the presence of filter paper which astonished chemists, and three years of continuous work have not answered all the questions which have arisen as to the effect of traces of organic impurity or of traces of acid or alkali, in the salt, or slight variations in the physical condition of the anode, or the volume and concentration of the electrolyte, or the density of the current, or the influence of dissolved gases. In addition to excellent facilities for purifying materials and making chemical determinations, and an unsurpassed equipment for measuring the current and weighing the deposits, the microscope and ultramicroscope have been brought into service. And although the outstanding discrepancies are only a few thousandths of one per cent., we have not felt justified in closing the work until the voltameter as a scientific instrument should be as thoroughly understood as possible.

The construction of standard cells has been beset with similar difficulties. The preparation of the materials has been studied with great pains, and hundreds of cells have been set up and carefully studied. To test their portability, they have been carried from country to country and around the world, and even sent through the mails to Europe and elsewhere. To try to determine the source of small differences between different lots of cells, and between different cells of the same lot, one component at a time has been varied, and materials prepared at different times and in different countries have been used side by side. The result has been a considerable improvement in standard cells, so that for most purposes they are satisfactory, but as standards there is still room for improvement.

One reason for desiring more perfect concrete electrical standards is to facilitate absolute measurements. We now know the value of the absolute ampere better than the value of the absolute ohm, but during the next few years the absolute ohm will probably be realized as well as the absolute ampere now is. Our international electrical units are now so well fixed that one can measure electrical power in international watts with great accuracy. With a better knowledge of the absolute ohm, we shall be able also under proper conditions to measure electrical and mechanical power in watts or in absolute units by means of electrical instruments with high precision.

The work at the Bureau of Standards

on the absolute measurement of current, using an improved form of Rayleigh current balance, has been thorough and exhaustive. To obtain a final result reliable to two or three parts in a hundred thousand requires that all possible sources of error as great as a few parts in a million must be examined and taken into account. It would be impossible in this form of current balance to measure directly the dimensions of the coils with the required precision, and hence the constant of the instrument must be determined by electrical means without such direct measurements; and to detect and eliminate unsuspected errors, several sets of fixed coils and several different moving coils were prepared and used interchangeably, giving the equivalent of several balances. This, in fact, did reveal unsuspected sources of error, and although it greatly prolonged the investigation, it gave results far more trustworthy in the end. A similar story could be told of the work at the bureau on mercury ohms, and on the determination of the ratio of the electrical units.

These are some of the researches in connection with electrical standards, which together constitute the third group of investigations in Division I. of the bureau. Some of them are described in papers contained in the *Bulletin*, and some are in press, and some are not yet completed.

(*d*) *Improvements in Instruments and the Development of New Instruments.*—In addition to new instruments developed and improvements made in existing instruments employed in the absolute measurements mentioned above, many improvements have been made in electrical instruments used for other kinds of electrical measurements.

Some of these improvements have been adopted by American and foreign instrument makers, and some are embodied only in instruments in our own laboratories. Among these may be mentioned the following:

(1) The Bureau of Standards type of sealed resistance standard, which is used not only for resistances of highest precision in standardizing institutions, but also for precision standards in ordinary use.

(2) The Bureau of Standards chronograph, for measuring and recording with extreme precision the speed of a machine, as, for example, the speed of a dynamo for the purpose of obtaining the frequency of the current generated with highest precision. It is used on the new apparatus for the measurement of absolute resistance at the bureau, and in connection with the absolute measurement of capacity and inductance, and has been adopted by the National Physical Laboratory on the magnificent machine recently erected at Teddington.

(3) The direct reading potentiometers designed for rapid and accurate work in the measurement of current and voltage, which have been of great service in the work of the bureau, and would be more largely used outside if instrument makers had been quicker to appreciate their merits.

(4) The series of electrodynamometers for the measurement of alternating current and power, which can be calibrated by direct current and used on alternating. Their range is up to 1,000 amperes, and one recently constructed, but not yet fully installed, will have a range of 5,000 amperes. They are essentially instruments for the testing laboratory, and without them the bureau would have been unable to make many of the tests which have been successfully carried out.

(5) Important improvements have been made in instruments for the accurate comparison of resistance standards and the testing of resistance boxes, potentiometers,

etc. In photometry a number of instruments have been developed or improved, including an automatic recording mechanism, a direct reading scale, a universal rotator, an improved integrating photometer, a direct recorder for life test work, an efficiency meter, etc.

Many other examples of the kind may be cited. In every case, instrument makers and the public have the fullest access to all information concerning new instruments or improvements in old instruments.

(*e*) *Determining the Properties of Materials*.—The fifth class of scientific investigations concerns the measurement of the properties of materials. Most of the work of this kind is included under the head of testing, the materials tested being in most cases samples of larger lots. But in some cases the work is done to find the average properties of a certain kind of material for the purpose of establishing a standard, or of finding how one property depends upon another. Examples of this kind are the investigations on the mean resistivity and temperature coefficient of resistivity of commercial copper wire. Samples were obtained from many sources, both in America and Europe, and values obtained from measurements made by one of the largest manufacturers, whose instruments and standards had been verified by the bureau.

In this way a mean value was obtained for commercial copper which was made the basis of a new wire table, computed by the bureau at the suggestion of the American Institute of Electrical Engineers, and which they at once adopted in place of their own table. These investigations also brought out a new relation between the temperature coefficient of resistivity and the resistivity itself, so that knowing either of these quantities, the other becomes known.

Another important investigation of this kind recently undertaken is on the relation between the magnetic and mechanical properties of iron and steel, with a view of ascertaining whether it is practicable to test materials for mechanical flaws by magnetic methods. Many investigations on the properties of materials employed in electrical work are needed to answer the hundreds of questions constantly arising, and some of these will soon be undertaken in cooperation with one of the committees of the American Society for the Testing of Materials.

3. ENGINEERING INVESTIGATIONS

In addition to work of the character just described under the head of scientific investigation, laboratory and field work have been conducted on several important practical questions, which may be mentioned under the head of engineering investigations.

One of these had to do with the use of electricity in mines, and the work was undertaken for the purpose of formulating a set of rules suitable for enacting into law, or that could be utilized in revising existing laws, concerning the safe use of electricity for light, power and signals in mines. A careful study of coal mines using electricity, and of the regulations of European and other countries concerning the use of electricity in mines, was made, a great many mining engineers, mine inspectors, mine superintendents and manufacturers of mining machinery were consulted, and the results embodied in a publication on the "Standardization of Electrical Practise in Mines."

Another investigation still in progress has to do with the state and municipal control of the manufacture and sale of illuminating gas. The bureau has been making a thorough study of the methods of testing

illuminating gas for chemical purity, and for its heating and illuminating value. This has involved an investigation of the methods of testing gas and of the instruments employed in such tests. That is, of apparatus used or that may be used in testing for hydrogen sulphide, total sulphur, ammonia, etc.; of gas calorimeters and of gas photometers and flame photometric standards. In connection with this the bureau has made a thorough study of the legal requirements in all the cities and states of the country and of the methods of testing and inspection in use, and has tried to formulate the results of these studies in such a way as to be useful in framing municipal ordinances or state laws on this subject. In this investigation a great deal of field work has been done, and some of the ablest and most experienced gas engineers and city and state inspectors and members of public service commissions have cooperated with the bureau. The results of this investigation, which has already been in progress for more than two years, will be published in two bulletins, one on the specifications of different kinds of illuminating gas and the public regulation of its distribution and sale, and the other on the methods of testing of gas and gas meters. In this work, three of the divisions of the bureau have cooperated.

Another investigation of great engineering importance is that of the effects of stray earth currents (due generally to street railways) upon the corrosion of gas and water pipes and of reinforced concrete structures. Experiments show that under certain circumstances such effects are not only real but serious. The bureau is doing a good deal of field work, as well as laboratory work on this subject, in order to learn the conditions under which the damage is greatest, and how best to remedy the trouble. The first public report of this work was made recently at the annual meeting of the American Gas Institute, and believing the bureau's work to be of great practical value, the institute voted to appoint a committee to cooperate with the bureau, and expressed the hope that the American Street Railway Association would do the same. Closely associated with the electrolytic corrosion due to stray electric currents is the electrolytic self corrosion, which is under some circumstances very serious and which is often wrongly attributed to railway currents. Electrolytic boiler corrosion, and the corrosion of metal lath used in building, are other examples of the same thing. These are also being investigated, and will be the subjects of published reports.

Another subject of great practical importance that remains to be studied is the life hazard in electric practise, and the proper regulations by states and municipalities for the protection of the public. Much attention is given by the Board of Fire Underwriters to the question of fire hazard, and in protecting buildings from the fire risk much has been done incidentally to reduce the risk to life. But too little attention has been given to the protection of the public from high potential power and lighting circuits, and few cities or states have legislated on the subject. A thorough study of this question, made with the fullest cooperation of the electrical power companies and the manufacturers of insulating materials, would yield results of great practical value, and open the way to municipal and state regulation and inspection.

4. THE TESTING OF INSTRUMENTS AND MATERIALS

Instruments and materials are tested by the bureau for the various departments of

the federal government and for the states and state institutions free of charge. For municipalities and corporations and individuals fees are charged, which in most cases scarcely cover the actual cost of the test, but which are high enough to exclude tests of small importance. In some cases the bureau declines to make tests, as, for example, when it is believed that the proposed test would not settle the question at issue, or where the work would be incommensurate with the value of the result, or where the test is simple and could be done as well elsewhere, and, of course, whenever the facilities or experience of the bureau are not sufficient to warrant attempting the work, or where the work already on hand is too great to permit it. But with these cases excluded, there remains a great variety of tests in all divisions of the bureau, which are being done for the government and the public, and many of these tests are of great practical importance. The fees charged are smaller than they would be if the tests were not generally of value to others besides those who pay for them. Most private tests, indeed, are of public advantage. For example, it is of public concern that manufacturers of electrical instruments have their standards tested at the bureau, as this tends to insure greater accuracy in the instruments sold to the public, without adding appreciably to the cost. That electric lighting companies have their test meters and voltmeters standardized and gas companies have their meter provers and photometric or calorimetric standards tested is a matter of public concern, for it improves the service rendered to the public. If manufacturers of electrical machinery have insulating materials tested for resistance and dielectric strength, and sheet iron and castings tested for magnetic quality, and copper tested for conductivity, their customers get better machines, and the public better service.

Electrical instruments tested by the bureau include standards of resistance and electromotive force, and precision resistance apparatus of all kinds; condensers and inductances of various kinds used in laboratory measurements and in radiotelegraphy, both commercial and experimental; ammeters, voltmeters, wattmeters, watt-hour meters and many other kinds of measuring instruments, for direct or alternating current; instrument transformers for current and voltage, including those for very heavy currents and high voltages; magnetic instruments; photometers, and various kinds of photometric standards, electric and gas, locomotive headlights, including oil, acetylene and electric; signal lamps, street lamps, etc.

Materials tested include copper, aluminum and other wires used as conductors of electricity; manganin, constantin and other alloys for resistance, thermal electromotive force, etc.; iron and steel and other magnetic or slightly magnetic materials for permeability, hysteresis, coercive force, etc.; sheet steels for iron losses due to alternating magnetizations; insulating materials for instruments and electrical construction; electric lamps for candle power, efficiency and life, and for the quality of the light furnished; oils to be used in standard lamps or as illuminant or for signal purposes, etc.

These tests of instruments and materials are sometimes made for the purpose of seeing whether they conform to the specifications under which they are sold, sometimes for the information of the manufacturer of the given instrument or material, sometimes for the information of an intending purchaser, often for the purpose of restandardizing the instrument for regular service. A great deal of time is required to keep the equipment employed in testing

in good condition, in order that it may give accurate and trustworthy results, and to check measurements previously made. In most kinds of testing, not half the total cost of the work is due to the time required to make the actual observations and calculations. But that is an inevitable condition, which never can be otherwise. For, if the work is not thoroughly reliable, its value has disappeared.

One of the interesting phases of this testing work is the uniformity which in some cases it maintains throughout the country in the output of different companies and the service rendered by different agencies. Before the bureau began its photometric testing, the standard of candle power varied from ten to twenty per cent. between different companies. The 16 candle-power standard lamps of different manufacturers varied from 14.5 to 17 candles. A 20 candle-power gas lamp on the average gave less light than a 20 candle-power electric lamp, for the unit in the gas industry was based on a different standard and was smaller. Now the unit of candle-power is the same for gas and electric light, and every manufacturer and every lighting company is on the same basis, for all get their standards, directly or indirectly, from the bureau.

Often tests are made to settle disputes, either concerning the accuracy of instruments or concerning the performance of a machine sold under guarantee. The confidence that has frequently been expressed in the justness and impartiality of the bureau's decisions, when thus acting as a court of appeal, has been gratifying to the officers of the bureau.

5. COOPERATION WITH ENGINEERING SOCIETIES

The bureau cooperates with many engineering societies and foreign laboratories in the work of standardizing and unifying practise, defining terms and improving nomenclature, working out uniform specifications and methods of tests, etc. In this work the division of Electricity, Magnetism and Photometry comes especially into contact with the American Institute of Electrical Engineers, the Illuminating Engineering Society, the Society for the Testing of Materials, the American Committee of the International Electrotechnical Commission and the International Committee on Electrical Units and Standards. The bureau is represented on the council or committees of all of these bodies, and each year many subjects arise that come within the field of the bureau's activities, and in the handling of which its representatives can cooperate. Reference was made above to the new tables of resistance for annealed copper wire. Heretofore, the English, German and American tables have all been different, not only for resistivity, but also for temperature coefficient, and two different densities were in use. Through the efforts of two of the above-mentioned bodies and the Bureau of Standards acting together in the negotiations with foreign laboratories and scientific societies, we are assured in the near future of international uniformity in all these quantities. Much has been accomplished also in securing international uniformity in electrical units, a common photometric unit in England, France and America, in comparing and standardizing measurements of electrical and magnetic quantities between national laboratories, etc.

The preparation of standard specifications for various kinds of materials is an important work, in which the bureau cooperates with the engineering societies and with the departments of the government.

6. COOPERATION WITH THE DEPARTMENTS OF THE GOVERNMENT

In addition to its cooperation with the departments of the government in the direction just noticed, and in doing testing in considerable quantity, the bureau cooperates with the departments also in other ways. With the War and Navy departments it cooperates in experimental work on radio-telegraphy, and several rooms in the bureau's laboratory are occupied by representatives of the signal corps of the army, and of the Navy Department, in this work. The bureau also renders technical assistance to the Bureau of Navigation, of the Department of Commerce and Labor, which is charged with the administration of the law requiring all passenger ships carrying fifty passengers or more to be equipped with radio-telegraphic apparatus. Its traveling inspectors visit the lamp factories and inspect for the various departments of the government a million electric lamps a year, taking samples for life test at the bureau.

7. DISSEMINATION OF INFORMATION

In addition to the scientific and engineering papers published in the *Bulletin*, and in the Bureau's Technologic Series thirty-one circulars of information have been published by the bureau on a variety of subjects, and among these nine have been prepared by the Electrical Division, and several others are in preparation. Among those issued may be mentioned "Standard Specifications for Incandescent Lamps," "A Proposed International Unit of Light," "Magnetic Testing," "Testing of Electrical Measuring Instruments," "Precision Measurements of Resistance and Electromotive Force" and "Transformer Specifications."

A large amount of time is expended in answering letters which request information. These come from many classes of inquirers, asking many kinds of questions, some very easy and some very hard to answer. All receive careful attention, no matter how humble the writer or how simple the question We in our turn write a great many letters asking for information, and we have to acknowledge the uniform courtesy accorded to such inquiries, and the valuable information often so obtained.

Much information is communicated also to those who call personally at the bureau, and this is naturally an increasing quantity. As the apparatus, methods of measurement and results for the most part are open to the public, many find it advantageous to make personal visits. An exception is made as to the results of tests for which a fee is paid, these being held as confidential and communicated only with the consent of the person for whom the test was made.

Enough has been said to show the great variety of the work in one division of the bureau, which may be taken as typical of all. It extends from the purely scientific investigations on the one hand to the most practical of engineering problems on the other. The work in electricity, magnetism and photometry is distributed among three different buildings, and needs more space. The new building now under construction, which will be 190 × 60 feet in floor area, with four stories and basement, will afford larger and better accommodations for this work.

In closing this necessarily incomplete account of the work of the electrical division of the bureau, let me say a few words as to the reasons for testing instruments and materials purchased by the government. Most people admit the advantage of such testing, but few appreciate how important it is, or how many sided is the question of

testing in connection with government purchases. It is of importance from a business standpoint, and as a matter of good engineering. It is also of great importance as contributing to good government.

8. REASONS FOR TESTING MATERIALS PURCHASED BY THE GOVERNMENT

1. The first and most obvious reason for testing instruments, machinery and materials purchased by the federal government is of course to insure the government getting what it pays for. But that is not the only reason, and in some cases it may not be the main reason. Such testing is done upon many kinds of materials, but for a concrete illustration we may think of electrical instruments or electric lamps.

(1) With the results of a thorough and impartial test at hand, a government engineer, charged with drawing specifications for a given kind of instrument or material, knows what performance can be secured by such instruments, or what properties can be expected in the given material, and hence is able to prepare the specifications intelligently.

(2) With the results at hand of tests on the instruments or materials of different makes, the purchasing officer knows what makers to invite to submit bids for government requirements. If those whose instruments or materials are unsuited for the given purpose are not permitted to bid, expense and trouble are avoided, both to the manufacturer and to the government.

(3) If the results of thorough tests are available, the purchasing officer can take account of the quality as well as the price in making awards of contracts. It often happens that any one of several makes of instruments or materials can be used, and it is necessary to know the differences in quality as well as the differences in price in order to determine which bid is best. The practise of accepting the lowest bid regardless of quality often causes dissatisfaction both to those who bid for the government's business and those who use the articles purchased.

(4) If tests are systematically made, a conscientious purchasing officer is protected from charges of favoritism or collusion in the performance of his duty. His answer to such intimations, whether they come from dealers or those in authority, is the certified results of tests upon which he had relied. If the tests have been made in an impartial and well-equipped laboratory established for the purpose, the results are likely to be given greater weight, and the protection to the purchasing officer is greater, than if done by the bureau or department making the purchase. Purchasing under such a system of testing, the opportunity and the temptation to collusion between purchasing officer and contractor is greatly reduced. Such collusion is not frequent in the government service, but it has occurred, and it is desirable to reduce the opportunity for it to a minimum.

(5) Purchasing under a system of thorough and systematic tests protects administrative and purchasing officers from political pressure in connection with purchases, and members of congress are spared from the appeals of constituents in connection therewith. It has sometimes happened that a manufacturer or contractor on failing to secure a government contract feels that he has been discriminated against, and in good faith goes to his congressman or senator with his grievance. The latter is placed in an embarrassing position, between his desire to serve his constituent and his uncertainty as to the real facts in the case. A system of fair and thorough testing of materials in connection with public advertising removes almost entirely

any occasion for appealing to a member of the legislative branch of the government concerning business transactions in the executive departments.

(6) If the instruments or materials are delivered from time to time, tests are necessary in order to see that the deliveries are in accordance with the samples or the specifications. If deliveries are accepted without tests or inspection, or with inspection only, the door is opened for deception and fraud; honest dealers or manufacturers are at a disadvantage in competition with unscrupulous ones in dealing with the government; and it may result under such circumstances that the most reliable manufacturers will refrain from bidding on government business, leaving those who are willing to misrepresent their products to compete with one another for the government patronage. The government then becomes a party to fraudulent transactions, and to a greater or less extent tends to demoralize business. On the other hand, if careful inspections and tests are regularly made, and acceptances are conditioned on meeting the specifications, manufacturers often thereby become better acquainted with the properties of their own products, honesty and uprightness in business are encouraged, a standard of quality is set for the given instrument or material which helps other purchasers besides the government, and the whole industry may be greatly benefited.

(7) If the reports of such tests are communicated to the manufacturers, as they generally are, defects in the product are perhaps sooner discovered and sooner remedied, and if the government invites the cooperation of the manufacturers when undertaking tests of types of instruments or of materials, the tests are likely to be fairly conducted and the results representative.

(8) In these days of commercial combinations and gentlemen's agreements as to prices, it sometimes happens that the government can not secure competition in price, but finds that the bids from different manufacturers are identical in price. Here again, testing the product solves an otherwise serious difficulty, for it is generally possible even in this case to secure real competition as to quality, and this is quite as important as competition in price.

It is thus seen that there are many reasons for testing the thousands of kinds of instruments, machines and materials purchased by the government, and for doing this, in large measure at least, in a well-equipped institution set apart for that purpose. The Bureau of Standards has done considerable work of this kind, but the government's purchases are so varied and so vast, and so many requests for tests came from states, municipalities, and the public, that the work involved is very great, and only a fraction of the work is done which could be done with profit. Whether the bureau shall grow in the future as fast as the demands upon it for testing and investigation increase is uncertain. But if it does only a part of the work waiting to be done, and does that part well, it will amply justify its existence, and in so doing save the government and benefit the industries far more than the cost of its maintenance.

EDWARD B. ROSA
BUREAU OF STANDARDS

PROGRESS IN INDUSTRIAL FELLOWSHIPS

IN the issue of SCIENCE for Friday, May 7, 1909, I presented the main outlines and contemporary status of a scheme of industrial fellowships initiated by me in an article in the *North American Review* for May, 1907. Since this statement I have made no report to this journal.

I now present the establishment of a new

series of fellowships, not only at the University of Kansas, but at the University of Pittsburgh. The industrial fellowships so far established at the University of Pittsburgh and now in operation are as follows:

1. *Baking.*—$750 a year for 2 years. Additional cash bonus of $2,000. Fellow: Wilber A. Hobbs, A.B., University of Kansas, instructor in chemistry.

2, 3. *Abatement of the Smoke Nuisance* (*Multiple Fellowship*).—$12,000 a year for 2 years. Additional consideration, 49 per cent. collective interest. Fellows: Raymond C. Benner (senior fellow), Ph.D. University of Wisconsin, assistant professor University of Arizona; W. W. Strong (second fellow), Ph.D. Johns Hopkins University, Carnegie assistant and assistant in chemistry Johns Hopkins University. Other fellows to be appointed.

5. *On the Relation of the Pots to Glass in Glass-making and the Elimination of "Strea."*—$1,500 a year for 2 years. Additional cash bonus of $2,000. Fellow: Samuel Ray Scholes, Ph.D. Yale University, H. B. Loomis fellow in chemistry Yale University.

6, 7, 8. *Baking* (*wholly Independent of but with Acquiescence of No. 1*) (*Multiple Fellowship*).—$4,750 a year for 2 years. Additional consideration of $10,000. Fellows: Henry A. Kohman (senior fellow), Ph.D. University of Kansas, holder of National Association of Master Bakers' fellowship; Charles Hoffman (second fellow), B.S. University of Kansas, laboratory assistant Yale University; Alfred Edward Blake (third fellow), B.S. New Hampshire College, assistant in chemistry Rensselaer Polytechnic Institute.

9. *Glue.*—$1,200 a year for 2 years. Fellow: Ralph C. Shuey, B.S. University of Kansas, former industrial fellow University of Kansas.

10. *Soap.*—$1,200 a year for 2 years. Fellow: Paul R. Parmelee, B.S. University of Kansas, curator of chemistry and pharmacy department, University of Kansas.

11. *Utilization of Fruit Waste.*—$1,000 a year for 2 years. Additional consideration, $10,000. Fellow: F. Alex. McDermott, George Washington University, of Hygienic Laboratory, Washington, D. C.

12, 13, 14, 15, 16. *Crude Petroleum* (*Multiple*).—$10,000 a year for 2 years. Collective interest of 10 per cent. Fellows: Raymond F. Bacon (senior fellow), Ph.D. University of Chicago, chemist Bureau of Science, Manila, assistant chemist Bureau of Chemistry, Washington, D. C.; Lester A. Pratt (second fellow), M.S. New Hampshire College, instructor at New Hampshire College; C. W. Clark (third fellow), M.A. Ohio State University, assistant chemist Bureau of Chemistry, Washington, D. C.; Hugh Clark (fourth fellow), M.A. Ohio State University; Arthur H. Myer (fifth fellow), A.M. Leland Stanford University, assistant department of chemistry, Stanford; Fred W. Padgett (scholar), University of Kansas.

17. *Composition Flooring.*—$1,500 a year for 2 years. 1 per cent. of sales for 5 years. Fellow: R. R. Shively, B.S. Oklahoma A. & M. College, assistant chemist Bureau of Chemistry, Washington, D. C.

18, 19. *Natural Gas* (*Multiple*).—$4,000 a year for 2 years. 5 per cent. of industrial results. Fellows: Clarence L. Speyers (senior fellow), Ph.D. Harvard University, Carnegie assistant Harvard University; Roy H. Uhlinger (second fellow), M.A. University of Pittsburgh, fellow in chemistry University of Pittsburgh.

20. *Cement.*—$1,800 a year for 2 years. $10,000 additional consideration. Fellow: J. F. MacKey, Ph.D. University of Toronto, former industrial fellow University of Kansas.

The fellowships above listed went into operation September 1 of the current year. They involve the work of twenty fellows and a salary list of $39,700 a year for two years, or $79,400 in all. The work is being conducted in a temporary but efficient building erected at a cost of about twelve thousand dollars.

At the University of Kansas, where this work has been in operation since 1907, I have to report the foundation of the following new fellowships, not yet published in SCIENCE:

10. *On the Chemical Treatment of Wood.*—$1,500 a year for 2 years. Large additional consideration. Fellow: L. V. Redman, Ph.D., University of Toronto.

11. *On New Utilities for Borax.*—$750 a year for 1 year. Fellow: B. C. Frichot, B.S., University of Kansas.

12. *On the Chemistry of Vegetable Ivory.*—$1,500 a year for 2 years. Maximum cash bonus of $2,000. Fellow: J. P. Trickey, A.B., New Hampshire College, University of Toronto.

13, 14. *On the Relation of Crude Petroleum to the Manufacture of Soap.*—$2,750 a year for 2

years. Maximum cash bonus of $5,000. Fellows: F. W. Bushong (senior fellow), Ph.D., former industrial fellow at University of Kansas; J. W. Humphreys (second fellow), A.M. University of Kansas.

15. *On the Chemistry of Gilsonite.*—$750 a year for 1 year. Maximum cash consideration of $2,000. Fellow: W. E. Vawter, A. B. University of Kansas.

16, 17, 18. *On the Chemical Treatment of Wood.*—$3,900 a year. Owing to the remarkable progress of fellowship No. 10 during the first year, the donating company extended its value to $3,900 a year and thus provided for the aid of two additional fellows. Fellows: L. V. Redman (senior fellow), Ph.D. University of Toronto; Frank P. Brock (second fellow), A.B. University of Kansas; Archie J. Weith (third fellow), A.B. University of Kansas.

Altogether, both at the University of Kansas and at the University of Pittsburgh, there have been so far involved $113,400 for direct expenditure in salaries in industrial research.

ROBERT KENNEDY DUNCAN

UNIVERSITY REGISTRATION STATISTICS

THE registration returns for November 1, 1911, of twenty-seven of the leading universities of the country will be found tabulated below. Seven institutions exhibit a decrease in the total enrollment (including the summer session) this year, viz., Chicago, Minnesota, Missouri, Nebraska, Northwestern, Texas and Yale, although in the case of Minnesota and Nebraska the apparent loss is due to a change of classification. The largest gains in terms of student units were registered by California (966), where the summer session showed an increase of 913 students, Columbia (527), Cornell (440) and

	Total Attendance[1] November 1, 1911	Attendance Summer Session, 1911	Grand Total	Deduct Summer Session Students who Returned in Fall	Net Total, November 1, 1911	Total, November 1, 1910	Total, November 1, 1908	Total, November 1, 1903
California	4051	1964	6015	291	5724	4758	3751	3690
Chicago	2666	3248	5914	524	5390	5883	5114	4146
Columbia	5669	2973	8642	704	79[illegible]8	7411	5675	4557
Cornell	4889	1152	6041	432	5609	5169	4700	3438
Harvard (incl. Radcliffe)	4724	787	5511	85	5426	5329	5342	6013
Illinois	4570	647	5217	288	4929	4659	4400	3239
Indiana	1350	1068	2418	264	2154	2132	2113	1143
Iowa	1772	309	2081	114	1967	1957	2356	1260
Johns Hopkins	740	335	1075	18	1057	784	698	694
Kansas	2019	429	2448	183	2265	2246	2086	1319
Michigan	4783	1194	5977	525	5452	5339	5188	3926
Minnesota	4307	476	4783	235	4548[2]	4972	4607	3550
Missouri	2273	507	2780	184	2596	2678	2558	1540
Nebraska	2474	403	2877	144	2733[3]	3661	3154	2513
New York	3688	490	4178	123	4055	3947	3951	2177
Northwestern	3387	94	3481	43	3438	3543	3113	2740
Ohio State	3085	792	3877	310	3567	3181	2700	1710
Pennsylvania	4718	682	5400	180	5220	5187	4555	2644
Princeton	1543	—	1543	—	1543	1451	1314	1434
Stanford	1634	50	1684	36	1648	1648	1541	1370
Syracuse	3183	225	3408	101	3307	3248	3204	2207
Texas	1935	734	2669	130	2539	2597	1446	785
Tulane	1192	936	2128	88	2040	1985	1171	1037
Virginia	804	—	804	—	804	688	757	638
Western Reserve	1331	—	1331	—	1331	1274	1016	765
Wisconsin	3956	1536	5492	477	5015	4745	3876	3221
Yale	3224	—	3224	—	3224	3287	3466	2990

[1] In all faculties, excluding preparatory or extension department.

[2] These figures do *not* include the registration in the two branch schools of agriculture, nor in any of the short courses, some of which were included in the previous years. The actual attendance this fall is practically identical with that of 1910.

[3] Certain classes of students counted in previous years must have been omitted in the total for 1911, since the institution reports a gain over last year.

Ohio State (386). Last year there were seven institutions that showed a gain of over three hundred students, California and Columbia being among the number. Omitting the summer session attendance, the largest gains have been made by Cornell (307), Ohio (282), Illinois (241), Columbia (223), Michigan (132), New York University (118) and Virginia (116). It will thus be seen that this year only four institutions exhibit an increase of over two hundred students in the fall attendance, as against seven in 1910 and eleven in 1909.

According to the figures for 1910, the twenty-seven universities included in the table ranked as follows: Columbia, Chicago, Michigan, Harvard, Pennsylvania, Cornell, Minnesota, California, Wisconsin, Illinois, New York University, Nebraska, Northwestern, Yale, Syracuse, Ohio State, Missouri, Texas, Kansas, Indiana, Tulane, Iowa, Stanford, Princeton, Western Reserve, Johns Hopkins, Virginia. Comparing this with the order for 1911, and leaving Minnesota and Nebraska out of consideration, we find that Columbia continues to maintain its long lead, that California has passed from the eighth to the second place, that Cornell has passed from the sixth to the third place, that Michigan and Harvard have each dropped down one place, Pennsylvania two places, and Chicago four, and that Wisconsin and Illinois have advanced a place owing to the change in the Minnesota figures. The balance of the institutions now rank in the following order: New York University, Ohio State, Northwestern, Syracuse, Yale, Nebraska, Missouri, Texas, Kansas, Indiana, Tulane, Iowa, Stanford, Princeton, Western Reserve, Johns Hopkins, Virginia. California is the seventh and Wisconsin the eighth institution to pass the five thousand mark. If the summer session enrollment be omitted, the universities in the table rank in size as follows: Columbia, Cornell, Michigan, Harvard, Pennsylvania, Illinois, Minnesota, California, Wisconsin, New York University, Northwestern, Yale, Syracuse, Ohio State, Chicago, Nebraska, Missouri, Kansas, Texas, Iowa, Stanford, Princeton, Indiana, Western Reserve, Tulane, Virginia and Johns Hopkins, the order of the first ten institutions last year on this basis being Columbia, Minnesota, Michigan, Pennsylvania, Harvard, Cornell, Illinois, California, Wisconsin, New York University.

The detailed statistics by faculties will hereafter be given in the spring, in order that the final figures for the year may be provided instead of the preliminary registration only. The number of students entering in the second term at the larger institutions is growing constantly, and as a result the final enrollment frequently shows a considerable increase over that of November first. The changes in attendance, equipment, etc., will also be submitted at that time.

The fall enrollment at a number of prominent colleges (for men and for women) and schools of technology is given in the following table:

Institution November 1	1911	1910	1904
Amherst	464	502	412
Brown (incl. graduate school)	933	930	988
Bryn Mawr (incl. graduate school)	440	409	441
Dartmouth (incl. eng., med., grad., stud., and commerce)	1,385	1,229	926
Haverford	164	150	146
Lehigh	599	616	609
Massachusetts Institute of Technology	1,610	1,506	1,561
Mount Holyoke	771	743	674
Purdue	1,762	1,611	1,359
Smith	1,508	1,618	1,067
Wellesley	1,433	1,378	1,050
Wesleyan	395	365	305
Williams	533	541	443

Rudolf Tombo, Jr.
Columbia University

SCIENTIFIC NOTES AND NEWS

Professor Edward C. Pickering, director of the Harvard College Observatory, has been elected president of the American Association for the Advancement of Science, to preside at the meeting to be held at Cleveland, Ohio, beginning on December 30, 1912.

Professor E. L. Thorndike, of Teachers College, Columbia University, was elected

president of the American Psychological Association at the recent Washington meeting.

COLONEL WM. P. GORGAS has been elected president of the ninth Congress of American Physicians and Surgeons, which meets in Washington in May, 1913.

PROFESSOR H. L. FAIRCHILD, of the University of Rochester, has been elected president of the Geological Society of America.

THE following have been elected foreign members of the Royal Society: Dr. Johann Oscar Backlund, of Pulkowa, imperial astronomer of Russia; Dr. Heinrich Ritter von Groth, professor of mineralogy in the University of Munich; Heinrich Kayser, professor of physics in the University of Bonn; M. Joseph Achille Le Bel, of Paris, the chemist, and Klement A. Timiriazeff, professor of botany in the University of Moscow.

LORD CROMER and the Hon. Lionel Walter Rothschild have been elected fellows of the Royal Society under the statute which empowers the council once in every two years to recommend to the society for election not more than two persons who in their opinion have rendered conspicuous service to the cause of science.

DR. CARLOS FINLAY, of Havana, has been elected a corresponding member of the Paris Academy of Medicine.

IT is stated in *Nature* that Professor G. Elliot Smith, F.R.S., professor of anatomy in the University of Manchester, has been awarded by the Paris Anthropological Society the Prix Fauvelle, of one thousand francs, for his researches in the anatomy and physiology of the nervous system.

GOVERNOR DIX has requested the resignation of Dr. Alva H. Doty as health officer of the Port of New York. Two weeks before a largely attended meeting of physicians of the New York Academy of Medicine, presided over by Dr. Abraham Jacobi, had passed resolutions requesting the reappointment of Dr. Doty, and referring to the admirable manner in which he had filled the position for the past sixteen years.

PROFESSOR VON WASSERMANN, the bacteriologist, has been appointed honorary professor at Berlin.

PROFESSOR ZIEMANN has resigned the charge of the public health service in Cameroon, Africa, on account of his health.

E. W. RUST, A.B. (Stanford), formerly at the Southern California Laboratory, has contracted with the Peruvian government for eighteen months as first assistant entomologist. He arrived in Peru early in December.

MR. L. H. WORTHLEY, assistant state forester of Massachusetts, in charge of the moth work, has accepted a position in the Bureau of Entomology. He will proceed to Europe to study the conditions on the continent.

MR. FLOYD B. JENKS, assistant professor of agricultural education in the Massachusetts Agricultural College, has accepted an appointment in the Bureau of Education.

PROFESSOR FINKLENBURG, of Bonn, has assumed the direction of the hydrotherapeutic institute, Berlin, as successor to Professor Strasburger.

Nature states that the presentation of a testimonial to Mr. Henry Keeping on his retirement from the post of curator of the Geological Museum, Cambridge, took place in the Sedgwick Museum on Saturday, December 2, when Professor T. McKenny Hughes handed him a purse subscribed by old friends and students in recognition of his long and valuable services. Mr. Keeping entered upon his duties as curator fifty years ago under Professor Sedgwick in the old Woodwardian Museum, where the geological department was located until its removal into the Sedgwick Museum in 1904.

PROFESSOR W. E. CASTLE, of Harvard University, who has left Cambridge to visit a number of countries of South America, chiefly Peru, wishes to obtain certain rodents for experimental work in genetics at the Bussey Institution. Part of the expenses of Professor Castle's trip are borne by the Carnegie Institution. He expects to return to Cambridge about February 1, although his trip may be prolonged until the first of March.

Hiram Bingham, professor of Latin-American history at Yale University, has returned from a six months' journey of exploration in Peru.

It is stated in *The Condor* that Mr. W. Leon Dawson spent a portion of the field season in out-door work contributory to his projected "Birds of California." The Farallone Islands and the Mount Whitney region were visited.

Mr. W. Bateson, F.R.S., director of the John Innes Horticultural Institution at Merton, Surrey, has been appointed the next Herbert Spencer lecturer at Oxford. The subject of the lecture, which will be given on February 28, is "Biological Fact and the Structure of Society."

We learn from *Nature* that the dean of Westminster, with the full concurrence of the chapter, offered to the family to permit the interment of Sir Joseph Hooker's ashes in the abbey, on the condition that his remains were previously cremated. The family has felt obliged to decline the offer as it was Sir Joseph's express wish that he should be buried by the side of his father at Kew. The funeral took place at Kew Parish Church on December 15.

Mr. William Thynne Lynn, formerly assistant in the Royal Observatory, Greenwich, and the author of various contributions to astronomy, especially on its history, died on December 11, aged seventy-six years.

Dr. David Starr Jordan, of Stanford University, one of the vice-presidents of the first international eugenics congress to be held at the University of London from July 24 to 30, 1912, has accepted the presidency of the consultative committee for the United States. The officers of the congress hope that it will result in a far wider recognition of the necessity for an immediate and serious consideration of eugenic problems in all civilized countries. The proof of this necessity must be based on the laws of heredity, on the history of the changes in racial characteristics in the past, and on what is known concerning the effect of all the many biological and social factors which tend either to improve or deteriorate the innate qualities of mankind. If this field should be covered in a wide and comprehensive manner in the papers presented to the congress, including an adequate discussion of the general nature of the reforms, moral and legislative, necessary for insuring the progress of the race, the records of the proceedings would form a presentment of the case for eugenic reform which would assuredly be of great value to both the legislator and the social reformer. To achieve such a result should be the main object, rather than the attempt to make the congress an arena for the discussion of academic questions mainly of interest to scientific investigators.

The Society for Biological Research of the University of Pittsburgh held the first of its special meetings for the year 1911–12 on December 14, at which time Dr. George Neil Stewart, professor of experimental medicine and director of the Cushing Laboratory at Western Reserve University, presented to the society the results of some of his recent work on the rate of the blood-flow in man. This plan of special lectures was inaugurated during the year 1910–11, by addresses on the "Hypophysis," by Dr. Harvey K. Cushing, of Johns Hopkins University, and on "Habit," by Dr. J. George Adami, of McGill University.

The President of Venezuela has issued a decree creating a National Bureau of Sanitation. Under its auspices will be inaugurated an Institute of Hygiene, which will be composed of a laboratory of bacteriology and of parasitology, a veterinary department, and a central station of disinfection. The staff of the bureau will be composed of a director, a subdirector, a bacteriologist, an engineer, a biologist, a veterinary surgeon, an inspector general, two technical aids, a secretary and two laboratory assistants.

The Boston *Transcript* states that a bill intended to give effect to the convention between the United States, Great Britain, Japan and Russia for the preservation and protection of the fur seals in the waters of the North Pacific Ocean will be considered by the house committee on foreign affairs very soon after

congress reconvenes. The treaty was concluded here last July and the final exchanges of ratifications between the governments ended two weeks ago. It now remains necessary only for the required legislation to be enacted. The bill to put the terms of the treaty into effect declares that no citizen of the United States shall kill or capture fur seals in the Pacific Ocean or seas of Bering, Kamschatka, Okhotsk or Japan north of the thirteenth parallel of north latitude, or kill sea otter in any of the waters beyond three miles from the United States shore line. Further, it is recited that no citizen of the United States shall equip or aid in equipping vessels to be used in pelagic sealing in these waters; that the importation of fur seal skins taken in those waters be prohibited except such as have been taken under authority of the respective governments parties to the convention to which the breeding grounds belong. Heavy penalties are provided by the bill for violations of its provisions.

The value of the total mineral output of Alaska in 1911 is estimated at $20,370,000, compared with $16,883,678 in 1910. The gold output in 1911 is estimated to have a value of $17,150,000; that of 1910 was $16,126,749. It is estimated that the Alaska mines produced 22,900,000 pounds of copper in 1911, valued at about $2,830,000; in 1910 their output was 4,241,689 pounds, valued at $538,695. The silver production in 1911 is estimated to have a value of $220,000, compared with $85,236 for 1910. The value of all other mineral products in 1911, including tin, marble, gypsum and coal, was about $170,000, an increase over that of 1910. By using the above estimates for the output of 1911, the total value of Alaska's mineral production since 1880, when mining first began, is found to be, in round numbers, $206,600,000, of which $195,950,000 is represented by the value of the gold output. The total production of copper in Alaska since 1901, when systematic mining of this metal began, is about 56,700,000 pounds, valued at about $8,170,000.

Mr. N. Hollister, assistant curator of the division of mammals, U. S. National Museum, announces the discovery of four new animals from the Canadian Rockies, in a paper just published by the Smithsonian Institution. During last summer a small party of naturalists from the Smithsonian Institution accompanied the expedition of the Alpine Club of Canada, to the Mount Robson region, where they made the first natural history collection ever taken in that vicinity. The paper mentioned above is the first publication issued by the institution on this expedition, although Mr. J. H. Riley, a member of the party, has written a description of two new species of birds discovered on the trip, which has recently been published in the *Proceedings* of the Biological Society of Washington; both of the birds are of the sparrow family, one a song sparrow, and the other a fox sparrow. The natural history work of the expedition was under the charge of Mr. Hollister. He paid especial attention, however, to the mammals, four of which he describes, a chipmunk, a manteled ground-squirrel and two bats. All the specimens come from the neighborhood of Mount Robson, which lies in one of the wild and unexplored parts of British Columbia, at about 14,500 feet elevation.

The Bureau of American Ethnology is preparing a new work which will form a "Handbook of Aboriginal Remains in the United States, and will have to do with the ancient abodes, camps, mounds, workshops, quarries, burial places, etc., of the Indian tribes. In connection with this work, Mr. F. W. Hodge, ethnologist in charge of the Bureau of American Ethnology, is sending letters of inquiry to all persons thought to have any knowledge of the subject of this undertaking, as well as to all institutions and societies interested in American archeology and ethnology. The letter requests all information respecting the location, character and history of the remains left by the Indians, or other indications of their former occupancy. In 1891 a catalogue of prehistoric works east of the Rocky Mountains was published, but that work is both out of date and out of print. It was compiled by Dr. Cyrus Thomas and

several collaborators. A large territory was covered in the first book and judging from the large map of the eastern United States, the parts of this country most densely populated by the aborigines must have been the basins of the Mississippi and Ohio rivers and the southern shores of the Great Lakes, although there are indications of many settlements on the Atlantic coast, especially in Florida. A large map showed all the locations, and smaller maps, of which there was one for each state, indicated the nature of each site by a special symbol. In the cartographic list, one found the meanings of the symbols readily; a single house drawn in outline represented a wooden lodge, while two houses represented a village; a grave was indicated by a special figure; a mound by the same figure reversed, and so on; enabling one, with a little study, to see at a glance exactly what was located at a certain point. It is not expected that the prospective work on Indian antiquities will be issued for many months. Following the precedent of the old report, the new one in completion, will show, to even a greater and more extensive end, all available information. It is proposed to classify the former Indian remains by states and counties, and to illustrate the publication with maps, photographs and drawings.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Edinburgh has received from the trustees of the estate of Mr. Robert Irvine the sum of £30,000, to establish a chair of bacteriology.

THE Cambridge council has voted the closing of the streets which cross the fifty acres of land fronting on the Charles River which the Massachusetts Institute of Technology proposes to purchase.

A NEW plan for the administration of the College of Agriculture, Cornell University, has been enacted by the university board of trustees to go into effect on January 1, 1912. The management of the college will be subject to the general supervision and control of the full board of trustees, and the immediate supervision, instead of being in the hands of the executive committee of the board, as now, will be entrusted to a special committee of eleven persons to be known as the Agricultural College council. Director Bailey has consented to remain at the head of the college long enough to put the new plan in substantial operation.

THE Annual Farmers' Short Course at the University of Missouri will be given this year beginning January 8 and continuing throughout the week. It is planned to give six short courses on soils and farm crops, animal husbandry, farm management, dairy husbandry, horticulture and poultry husbandry. The class rooms and laboratories of the Agricultural College will be thrown open during this week to the farmers of Missouri. The entire teaching force of the college, consisting of more than forty men, will, by lecture and demonstration, give instruction in the subjects and will describe the experiments conducted by the Experiment Station. The state board of agriculture, cooperating with the college, has provided for the evening lectures. President K. L. Butterfield, of Massachusetts; Dean H. L. Russell, of Wisconsin; Jos. E. Wing, of Ohio; A. N. Abbott, of Illinois; Herbert Krum, of Kentucky; Uriel W. Lamkin, of Missouri, and many others will address the farmers. The annual Farmers' banquet, given by the College of Agriculture and consisting largely of products grown on the college farm, will be given Friday night, January 12. The beef will be from an international prize winner, the cream and butter from the Dairy Department and fruits and vegetables from the Department of Horticulture. Governor Herbert S. Hadley will be present during the week.

THE minister of education has laid before the Hungarian parliament a bill which provides for the erection of two new universities in Hungary, in the cities of Pressburg and Debreczin.

PROFESSOR E. G. MONTGOMERY, of Nebraska University, has been appointed professor of

farm crops in the College of Agriculture of Cornell University.

DR. H. BASSETT, of the University of Liverpool, has been appointed professor of chemistry at University College, Reading.

DR. W. R. BOYCE GIBSON, lecturer in philosophy at the University of Liverpool, has been appointed professor of mental and moral philosophy at the University of Melbourne.

DISCUSSION AND CORRESPONDENCE

"GENOTYPES," "BIOTYPES," "PURE LINES" AND "CLONES"

IN a recent issue of SCIENCE[1] Dr. Jennings calls attention to a double meaning which has been given to the word "genotype" by several recent writers, myself among them, and points out the desirability of limiting the word to the meaning assigned to it by its originator, Dr. Johannsen.

As one of the chief offenders, I wish to publicly repent my misuse of the term and to heartily join in the movement to limit the word "genotype" as used in the literature of genetics, to the fundamental hereditary constitution of an individual. The use of this word both for the hereditary constitution and for the group of individuals possessing an identical hereditary constitution, will lead to much confusion if continued.

The word which Dr. Jennings says is much needed "for a concrete, visible group of organisms" "all with the same hereditary characteristics," has been already supplied. In a symposium on the "Aspects of the Species Question" before the Botanical Society of America at Chicago, January 1, 1908, I pointed out[2] the same need and expressed a hope that some one would "come forward with an acceptable short designation" for these "elementary forms" which had been classified by de Vries as "elementary species" and "varieties." A few months later I discovered that my wish had been fulfilled before its utterance, by Dr. Johannsen, and his word "biotype"[3] was immediately adopted in my paper on "The Composition of a Field of Maize"[4] and made a part of the title of my work on "*Bursa bursa-pastoris* and *Bursa Heegeri*: Biotypes and Hybrids."[5] In view of these facts there was no excuse for my use of the word "genotype" in a taxonomic sense.

Dr. Jennings also calls attention to an important misuse of the expression "pure line," and here I must again admit a certain amount of guilt, as I was probably the first to include under this term groups of individuals related through the process of budding or any other method of vegetative reproduction. In 1904 I wrote:[6]

> By the "pure line" Johannsen means a series of individuals related only through the process of self-fertilization. On *a priori* grounds it seems proper to apply the term to every series of individuals that do not combine elements of two or more ancestral lines through the equivalent of a sexual process. Thus, so far as hereditary qualities are concerned, there should be no reason to expect in a self-fertilizing population conditions different from those in a population related through budding or other method of vegetative reproduction, provided, of course, that the self-fertilizing population has not been so recently modified by a cross as to allow the analysis and recombination of characters derived from different ancestral lines.

For this early departure from "the narrow path" I have in part atoned in my recent paper on the "Genotypes of Maize,"[7] by referring to the vegetatively reproduced potato and paramecium as "clonal varieties," in contradistinction to the self-fertilizing "pure

[1] SCIENCE, December 15, 1911.

[2] *Amer. Nat.*, XLII., 278, May, 1908.

[3] This word was first proposed in 1905 in "Arvelighedslærens Elementer," the Danish forerunner of "Elemente der exakten Erblichkeitslehre," and was first used in English at the Third International Conference on Genetics in 1906. (See Report Third International Conference on Genetics, p. 98, 1906.)

[4] Report American Breeders' Association, IV., 296–301, 1908.

[5] Carnegie Institution of Washington Publication No. 112, 1909.

[6] *Torreya*, V., 22, February, 1905.

[7] *Amer. Nat.*, XLV., 234–252, April, 1911.

lines" of beans, barley, etc. I might equally well have called them simply "clones," as "clonal varieties" and "clones" should have identical meaning. The word "clone" (Greek κλων, a twig, spray, or slip) was proposed by Webber[8] for "groups of plants that are propagated by the use of any form of vegetative parts, such as bulbs, tubers, cuttings, grafts, buds, etc., and which are simply parts of the same individual seedling." I believe that no violence will be done by extending this term to include animals which are similarly propagated by any asexual method, and I suggest the general adoption of the word "clone" for all groups of individuals having identical genotypic character,[9] and arising by asexual reproduction of any sort, including apogamy (*i. e.*, so-called "parthenogenesis" unaccompanied by a reduction division).

For the purposes of my discussion in 1904 the distinction between "pure lines" and "clones" was of no consequence, because the particular hereditary principle then under consideration was common to both. The same thing is no doubt true of many of the recent investigations of others, but it is well to remember that there are certain fundamental differences between "pure lines" and "clones," which render it very important to maintain the distinction between them. I will mention but two of these differences by way of example: (1) In the "clone" it is possible to retain as a permanent feature of the group any purely heterozygous character, as for instance the vigorous constitution dependent upon the stimulation of heterozygosis; such a phenomenon is impossible in the "pure line." (2) When clonal individuals reproduce sexually, either by self-fertilization or by crossing with other individuals, they need not, and usually do not, produce genotypically equal offspring, because the individuals of the "clone" are not necessarily homozygous, as the individuals of the "pure line" generally are. The "clones" of horticultural plants are notorious for the heterogeneity of their seedling offspring. The investigator of intermittently parthenogenetic organisms like aphids, rotifers and Hieracium, and of intermittently vegetatively produced organisms like paramecium and many plants, can not properly assume that their races are genotypically pure in the sense that they are homozygous, while the worker with "pure lines" can make such assumption with small probability of error, in case his self-fertilizations have been controlled with adequate care during a sufficiently large number of generations.

There is another prevalent misconception regarding "pure lines," to which attention needs to be called. The word "pure" in this connection does not refer to the genotypic equality of the individuals, but only to the exclusion of all crossing as a source of genotypic differentiation.

In Dr. Harris's criticism[10] of Roemer's work with peas, he points out with very evident satisfaction that two of Roemer's populations are historically traceable to individual selections and that they are therefore really "pure lines" (*i. e.*, providing, of course, that those originally selected individuals were strictly homozygous, and that no chance crossing has taken place since). If no genotypic changes can take place within the "pure line" all evolution is impossible in the large number of forms which naturally maintain "pure lines" by obligate self-fertilization. The only point to be made in regard to this feature of Roemer's results, is that, if his populations were really "pure lines," the numerous distinct biotypes he discovered by the "pure line" method in those populations, were the result of mutations which have taken place since the original selections were made. The occurrence of such mutations does not affect in the least the value of the genotype theory, nor the importance of the "pure line" method for the study of heredity.

[8] SCIENCE, XVIII., 501–503, October 16, 1903. For a discussion of the spelling of the word "clone" see SCIENCE, XXII., 89, July 21, 1905.

[9] This restriction is necessary in order to avoid confusion through the appearance of bud-mutations. Such a mutation if propagated vegetatively represents the origin of a new clone.

[10] *Amer. Nat.*, XLV., 686–700, November, 1911.

Definitions:

Genotype, the fundamental hereditary constitution or combination of genes of an organism.

Biotype, a group of individuals possessing the same genotype.

Pure line, a group of individuals traceable through solely self-fertilized lines to a single homozygous ancestor.

Clone, a group of individuals of like genotypic constitution, traceable through asexual reproductions to a single ancestral zygote, or else perpetually asexual.

GEO. H. SHULL

HISTORY OF MATHEMATICS IN THE RECENT EDITION OF THE ENCYCLOPÆDIA BRITANNICA

THE new edition of the Encyclopædia Britannica contains numerous articles which purport to deal with the history of various branches of mathematics. None of these have been written by specialists in this field and the articles bear abundant evidence of this fact. The history of mathematics may well ask of the editors of such an encyclopedia the same care in the selection of writers on these topics as that exercised in the selection of writers in other fields, ably represented in general in the Britannica by the leading scholars of the world.

In a recent issue of SCIENCE (December 1, 1911) Professor G. A. Miller has called attention to certain inaccuracies and errors, especially with reference to the theory of numbers and of groups. It seems to me unfortunate, in view of the general worthlessness of the historical passages, that Professor Miller has incidentally chosen for criticism one of the few correct statements. The passage in question occurs on page 867 in volume XIX., in the article on "Numerals" in which the writer states that our present decimal system is of Indian origin. Attention is rightly called by Professor Miller to the fact that the zero appeared in Babylon long before it appeared in India, although the writer on "Numerals" seems to be unaware of this. However, the date is not 1700 B.C., as Professor Miller states, but more than a thousand years later. Photographic reproduction of Babylonian tablets containing the zero appear in F. X. Kugler's "Die babylonische Mond-rechnung," Freiburg i. Br., 1900, and these tablets date from the centuries just before the Christian era. Furthermore, no historian of mathematics has made the claim that modern arithmetic is derived from the Babylonian arithmetic, as Professor Miller implies, but there is general agreement that our arithmetic comes to us from the Hindus through the Arabic writer (c. 825 A.D.) Mohammed ben Musa Al-Khowarizmi. This subject is fully discussed in "The Hindu-Arabic Numerals," Smith and Karpinski, Boston, 1911.

The article on "The History of Mathematics," Vol. XVII., pp. 882–883, is too brief to invite comment. The incorrect statement is made: "The medieval Arabians invented our system of numeration." Reference is given only to the works of Cantor ("1st Bd.," "2d Bd." and "3d Bd."!) and to W. W. R. Ball's "A Short History of Mathematics," London, 1888, and subsequent editions. The latter work is in no sense an authority on the subject.

The articles on "Algebra, History," Vol. I., pp. 616–620, and "Geometry, History," Vol. XI., pp. 675–677, contain so many inaccuracies and so much misinformation that selection becomes difficult. I will devote myself more particularly to the longer article on the history of algebra.

Some ridiculous statements made by Peter Ramus in his algebra of 1560 are quoted. Thus Ramus says: "There was a certain learned mathematician who sent his algebra, written in the Syriac language, to Alexander the Great, and he named it *almucabala,* that is, the book of dark or mysterious things, which others would rather call the doctrine of algebra . . . and by the Indians . . . it is called *aljabra* and *alboret.*" This nonsense, evident on its face, as *almucabala* and *aljabra* are Arabic words, is taken somewhat seriously by this writer in the Britannica. "The uncertain authority," he says, "of these statements, and the plausibility of the preceding explana-

tion, have caused philologists to accept the derivation from *al* and *jabara*." The "preceding explanation," to which reference is made, is the correct one, viz., *algebra* from the first part of the title of Mohammed ben Musa's work on the subject.

Very evidently the writer has only secondhand information about the works of this great Arabic writer to whom the mathematical world is indebted for its knowledge of the Hindu numerals and also for the first systematic treatise on algebra. This is the more to be regretted, coming from Cambridge, since the unique copy of an early (twelfth century) Latin translation of Mohammed ben Musa Al-Khowarizmi's arithmetic is in a Cambridge library and the unique copy of the Arabic algebra is in Oxford and was translated into English in 1831 by F. Rosen. The arithmetic was published by Boncompagni, "Trattati d'Aritmetica," Rome, 1857. The writer in the Britannica regards the two as a single work and his comments on the indebtedness to Greek and Hindu sources are, of course, worthless.

Incorrect is the assertion that the thirteen books of Diophantus's "Arithmetica" are not lost, but this statement, it is only fair to say, may be due to a misprint. Bhaskara, a Hindu mathematician of the twelfth century, made great advances over the algebraic work of Brahmagupta (seventh century), although the Britannica states the contrary. John Pell's algebra of 1668 does not exist nor did he anywhere present the solution of the so-called Pellian, $x^2 - ay^2 = 1$. Pell did in 1668 have in print, simply under his initials, some comments on Brouncker's translation of Johann Heinrich Rahn's "Algebra." To Simon Stevin of Bruges is ascribed the publication of "an arithmetic in 1585 and an algebra shortly afterwards." Both were combined in one volume in 1585, as D. E. Smith shows in the "Rara Arithmetica," Boston, 1909, pp. 386–388. Stevin's fame as the first writer to give an exposition of decimal fractions seems not to be known to this writer, for the statement that Stevin "considerably simplified the notation for decimals" is wide of the mark. Approaches to decimal fractions appeared before Stevin, but no exposition and no notation for Stevin to simplify.

The revival of the study of algebra in Christendom is incorrectly attributed to Leonard of Pisa (1202 A.D.). Robert of Chester, an Englishman living in Segovia, Spain, translated into Latin in 1145 A.D. the Arabic algebra of Mohammed ben Musa. Only a little later Gerard of Cremona treated the same work and about the same time Plato of Tivoli translated into Latin a work dealing with quadratic equations by Savasorda (twelfth century). The revival of mathematics in Christendom begins with these men and others who like them were occupying themselves with translations from the Arabic. The statement that the work of Leonard "contains little that is original, and although the work created a great sensation when it was first published, the effect soon passed away and the book was practically forgotten," is as false as it is ridiculous.

Now this writer turns immediately to discuss Luca Paciuolo and then states: "These works are the earliest printed books on mathematics." How this glaring blunder "got by" the editors is difficult to understand. Leonard of Pisa's work was not in print until 1857, when Prince Baldassare Boncompagni published it and even Paciuolo's "Summa de Arithmetica" did not appear until 1494. The first printed arithmetic is probably that of Treviso, 1478. Between that time and 1494 many important works appeared. No less than three editions of Pietro Borghi's arithmetic (1484, 1488 and 1491) and some six editions of the three different works on arithmetic by J. Widmann (1488, 1489, 1490, 1493), are included among these books. The Algorismus by John Halifax (Sacrobosco) appeared in two editions (1488 and 1490?). Philip Calandri published in 1491 an arithmetic with illustrated problems and Francesco Pellos (Pellizzati) got out an arithmetic in the year that Columbus discovered America. Peurbach's Algorismus (1492) and others could be added to this list.

The transliteration of Arabic names is en-

tirely original, as, for example, Tobit ben Korra for Thabit ben Qorra.

The most amusing statement is, "Fahri des al Karhi, who flourished about the beginning of the eleventh century, is the author of the most important Arabian work on algebra." Now Al-Fakhri, or Fakhri, is, indeed, the title of an Arabic work on algebra by one Abu Bekr Mohammed ibn Al-husain Al-Karkhi, or Al-Karkhi, for short. But the *des* seems, at first, unexplainable. The probability is that the *des* is German and some chance reference in German to the Fakhri des Al-Karkhi, the Fakhri of Al-Karkhi, undoubtedly accounts for this Farhi des Al Karhi.

Equally bad from a mathematical point of view is the surprising statement that "the Arabs accomplished the general solution of numerical equations."

The shorter article by the same writer on "Geometry, History," contains, of course, fewer errors. We must regard it as fortunate, in view of the errors I have shown and others not noted in the article on the history of algebra, that there is no article on the history of arithmetic. In pleasing contrast to these articles mentioned is the summary of the history of trigonometry by E. W. Hobson.

The one man best qualified to write a summary of the history of algebra and also of geometry is undoubtedly Sir Thomas L. Heath, sometime fellow of Trinity College, Cambridge. Even in 1910 the Cambridge University Press published a second edition of Heath's "Diophantus" and in 1908, Heath's "The Thirteen Books of Euclid's Elements," in three volumes. We may well express our surprise that the fame of Sir Thomas Heath should not be known to his Alma Mater, which stands sponsor for the encyclopedia, and that his aid was not sought for the history of mathematics in the Britannica.

L. C. KARPINSKI

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DEVASTATION OF FORESTS IN THE WHITE MOUNTAINS

To those who have supposed that the Weeks bill for the preservation of the Appalachian forests has settled a long-debated question, and that the advocates of the measure may now take a rest, secure in the belief that its execution is in the hands of a scientific man, armed both with authority and with knowledge, the article by Winthrop Packard in the *Boston Transcript* for October 7, 1911, stating the results of his exploration of the White Mountain region during the past summer will be a distinct shock.

"Lumbering," says Mr. Packard, "used to be a winter job, but there is no let-up in the rush now on to get the last spruce off the high levels of the White Mountains." The Weeks bill "is still about to work. But meanwhile the only part of it which is really working is the joker . . . which makes it indefinitely inoperative." An "innocent little paragraph in the Weeks bill says, in effect, that the head of the United States Geological Survey shall decide what areas are to be reserved along the head waters of the navigable rivers."

"Meanwhile, whether it affects the navigation of the Connecticut, the Androscoggin, the Saco and the Merrimac or not, the last of the good black growth of spruce, fir and hemlock is rapidly coming off the higher slopes of the Presidential Range and the lesser ranges that surround it."

"The best of the beautiful primeval forest is still above the high-water mark of this cutting, but it will take only a winter or two to encompass its downfall, and the investigations of the Geological Survey may probably be depended upon to hold the Weeks bill by the throat for that length of time, if not forever.

"The largest body of spruce left within sight of Mount Washington is that which lies at the head of the Rocky Branch Valley, between the Montalban Range on the west, the Rocky Branch Ridge on the east and Boott's Spur. . . . Here are some square miles of splendid black growth. . . . It is a virgin forest which one might suppose would last because of its inaccessibility. It is walled in by mountains on three sides and is sixteen miles up a tremendously rough valley from the south. This valley is drained by a tributary

of the Saco, a stream so capricious and boulder-strewn that it would be an impossibility to drive logs down it. But spruce and hemlock are exceedingly valuable nowadays, and, morever, that Weeks bill threatens—or would threaten if it were not for that little joker—to prevent the slaughter of trees so near Mount Washington. So a lumber railroad has been driven with great energy up to the very center of this last refuge of the forest primeval."

In the Crawford Notch the cutting has been carried as far up as the Frankenstein Trestle. "The whole easterly slope of the Franconia Range and the valleys among the foothills of this range have been denuded. Indeed, from the summit of Lafayette almost all that the eye can see of the lower and western part of the Pemigewasset Valley has been swept clean and left a leafless, brown desert of slash. So from Carrigan Summit it shows on the southerly slopes of Bemis, Anderson, Lowell and Nancy."

It is evident from the above that the cutting of the forest is progressing at an unprecedented rate, and this, not merely on the lower and more gentle slopes where there is a possibility that the growth of spruce may be renewed, but also on the upper and steeper inclines where the forest, when once removed, is gone, if not forever, still at least until the next Ice Age wipes out the relics of human folly, renews the mantle of drift, and restores, after the recession of the ice, those climatic conditions which make the initiation of evergreen forests possible in such situations.

At the conference of governors, called by President Roosevelt to consider the conservation of our natural resources, after reciting the axiom: "The great natural resources supply the material basis upon which our civilization must continue to depend and upon which the perpetuity of the nation itself rests," the conference made the following unanimous declaration:

"We agree, in the light of the facts brought to our knowledge and from information received from sources which we can not doubt, that this material basis is threatened with exhaustion. Even as each succeeding generation from the birth of the nation has performed its part in promoting the progress and development of the republic, so do we in this generation recognize it as a high duty to perform our part; and this duty in large degree lies in the adoption of measures for the conservation of the natural wealth of the country." It was further declared that "this conservation of our natural resources is a subject of transcendent importance, which should engage unremittingly the attention of the nation, the states and the people in earnest cooperation."

All of this is matter for consideration in the light of science. As abstract questions, these declarations received universal acquiescence; but diversity of opinion arises in their application, and here we enter upon a sphere of action where science and politics must combine. Distasteful as it may be to men of science to enter into the sphere of politics, the lesson which the laborers have been slowly learning, that the needs of industry receive no attention until pushed to the center of the political arena, must apparently be taken home by science also.

One of the declarations of the governors reads: "That sources of national wealth exist for the benefit of the people, and that monopoly thereof should not be tolerated." Here this honorable body touches the crux of the whole matter.

As soon as remedial legislation is attempted, the forces of monopoly show themselves to be stronger than science, stronger than governors or presidents. In fact, there is only one power that is greater—that of the people. Whenever the nation becomes so thoroughly aroused that its people act together as one man, monopoly will be overthrown. Until that time arrives, there is need for science to continue a campaign of education and to continue it *unremittingly* as the governors advise.

After the first flush of enthusiasm has cooled, look for reaction and apparent back track to make way for the next wave of advance. The need of a new movement is

already immanent. Though the campaign of education may flag, the exploiters of the nation's resources, who act without regard to ultimate consequences and for self-interest only, anxious lest their special privileges may be curtailed, are not letting the grass grow under their feet.

It becomes necessary for men of science to reiterate the fundamental facts, which they can do in the present instance with the certainty that scientific prognostications anent the passing of the forest and its resulting woes can not be made too loud or too often. The American Association for the Advancement of Science, whose memorial in 1873 was one of the beginnings of the present conservation movement, could not do a better thing than to present at its coming session another memorial to Congress, recounting the lessons which the engineers have been learning.

Professor Willis L. Moore, in his report as Chief of the Weather Bureau for 1909–10 (p. 18) says: "After an elaborate research into all available data, the Weather Bureau, in company with many eminent engineers, concludes that on the principal rivers the floods are not higher or longer continued or the low water lower than forty years ago, while other persons hold to the opposite." Nothing whatever is said as to changes in forestation of the river-basins investigated during the forty years, a point on which Professor Swain has commented in his review[1] of another work by the same author. In the more thickly settled parts of the country, deforestation was already far advanced forty years ago. Attention to earlier records shows a very different condition.

Mr. Joseph B. Walker, writing in 1872, said that "the rapid destruction of the forests" of New Hampshire was then "painfully apparent everywhere"; and in 1891 the same author said: "The volumes of our streams are less equable than formerly. In summer they are greatly reduced. Many brooks whose flow was once perennial are no longer to be found for one half of the year. This fact is due to the total or partial denudation of the land from which they flow. So serious an evil had this become, some thirty or forty years ago, that the manufacturing companies upon the lower part of the Merrimac were forced to construct vast storage reservoirs, at great expense, which can be drawn upon as water is wanted. Winnepesaukee Lake and Long Pond are two of these. Total denudation at the source of our streams would convert them into destructive torrents in spring and their channels into dry ditches for the rest of the year." The last is of course an inference, but one that is not improbable.

Similar occurrences have taken place in central New York. "With the clearing away of the forests and the burning of the forest floor came a failure of canal supply that necessitated the building of costly dams and reservoirs to replace the natural ones which the fire and axe had destroyed. The Mohawk River, which for years had fed the Erie Canal at Rome, failed to yield any longer a sufficient supply, whereupon the Black River was tapped at Forestport, and its whole volume at that point diverted southward to assist the Mohawk in its work." The reports of the superintendent of public works in New York State, thirty or more years back, reiterate the progressive failure of the water supply and appeal for the protection of the forests. We hear less of these complaints to-day simply because the railroads are in full control and many of the early canals are abandoned. But the time will surely come when this policy will be recognized as a mistake.

B. E. Fernow, in a paper on the "Relation of Forests to Water Supplies," writing in 1892,[2] cites the earlier changes in the Schuylkill River: "During the last sixty or sixty-five years," he says, "this river has shown a marked diminution in its *minimum* flow. In

[1] "The Influence of Forests on Climate and on Floods," a review of Professor Willis L. Moore's report, by George F. Swain, LL.D., professor of civil engineering, Harvard University, *American Forestry*, Vol. 16, pp. 224–240, April, 1910.

[2] Bulletin No. 7, Forestry Division, U. S. Department of Agriculture, 1893, p. 165.

1816 this flow was estimated at 500,000,000 gallons per day; in 1825 at 440,000,000; in 1867 at 400,000,000, and in 1874 at 245,000,000. In regard to this a commission of engineers say in their report in 1875: This remarkable decrease, not being accompanied by any great change in the rainfall, is no doubt largely due to the destruction of the forests in the drainage area, whereby the conservative action of the woodland has been lost, and the rainfall is permitted to descend rapidly to the bed and pass off in a succession of freshets."

The same bulletin (pp. 23–122) contains an elaborate "Review of Forest Meteorological Observations," by Professor Mark W. Harrington, who treats the data obtained at a considerable number of German stations by an original system of curves, bringing out the fact that the forest is cooler than the neighboring open country by several degrees. Being cooler, the dew-point is reached more quickly in the forest, when atmospheric conditions favor rain. The forest has (1) larger evaporation from widespread leafy surfaces and moist shaded soil, (2) cooler atmosphere from the local evaporation and (3) greater precipitation. Effects (1) and (3) so nearly compensate that there is hardly any difference in the total run-off from a given area, whether forested or not, but a great difference in the distribution of the flow in its annual fluctuation.

The forest question is not a meteorological problem, but one of soils, erosion and drainage. In France enormous sums of money are being expended in a toilsome effort to undo the mistakes of the past and to reforest the steep slopes. It seems strange that "eminent engineers" should not be aware of these facts, and that our country must repeat all of these unhappy blunders of older nations without profiting by their experience.

The French writer, Belgrand, quoted by Professor Swain, touches the heart of the matter when he says: "The forests diminish very notably the volume of earthy matter transported by the streams, because they prevent the erosion of the earth, and it must be recognized that the impoverishment of the earth is much more to be deplored than the disasters caused by floods."

In the report of the chief of engineers, U. S. Army, for 1891 (p. 1107), Major Charles W. Raymond says: "The destruction of forests from the mountain crests and slopes of a watershed is undoubtedly the principal cause of the increase of the average magnitude of floods. The evidence collected during the last twenty-five years establishing this conclusion is well nigh overwhelming, and it is verified by repeated observations, not only in the mountains of Europe, but also in our own land"; and he refers to Colonel Torrelli, who "affirms as the result of careful observations that four fifths of the precipitation in forests is absorbed by the soil or detained by the surface of the ground to be gradually given up in springs and gentle rills, and only one fifth of the precipitation is delivered to the rivers rapidly enough to create floods. Upon the same slopes and surfaces denuded of their forests, the proportions are reversed. . . . That the destruction of the forests in mountainous watersheds is followed by disastrous floods where previously such floods were unknown is not a matter of theory, opinion or probability, but it is a well-established physical fact."

"In France, Italy, Germany and Austria the systematic planting of mountain slopes as a means of restoring lost fertility and preventing the inundations following the destruction of forests, is an established fact followed by results more satisfactory than the most sanguine anticipations."

The attempt to divert attention from the problem of the forest on the plea that it involves unsolved meteorological questions is an obscuring of the real question which concerns the soil. Governmental authority has been invoked ostensibly on account of increased difficulties and dangers to navigation of the rivers through neglect of their forest sources. Such perturbations of the streams do undoubtedly result from deforestation of the mountain slopes, but of far greater importance is the injury to the soil. The soil of

our native land should be even more sacred than its waters, and if necessary the constitution should be amended to enable the Congress to pass laws protecting the soil as well as the waters of our common heritage.

FRANK W. VERY

WESTWOOD, MASS.,
November 25, 1911

SCIENTIFIC BOOKS

Characteristics of Existing Glaciers. By WILLIAM HERBERT HOBBS. New York, The Macmillan Company. 1911. Pp. ix + 301.

The author tells us that the book consists of three articles, more or less amplified, which he has contributed to scientific magazines. This explains the general character of the book, which is divided into three parts; the first deals principally with glacial erosion; the second with the ice masses of the Arctics and the third with those of the Antarctics. The subject is treated in regard to some of its larger aspects, such as geographical distribution, the general forms and the meteorological relations of the ice masses. The physical character of the ice which controls its movements, the relation of reservoir to dissipator, the formation of moraines and many other details are absent, as might be expected from what has been said above. On the other hand, far more space is given to the question of erosion and to meteorological conditions than is usual in books about glaciers.

In the first part, the subject of glacial erosion, both at the bottom of the valley and in the cirque wall, is considered. Here, for the first time, accounts of Matthes's theory of nivation and Willard D. Johnson's theory of bergschrund sapping are given to the general public. The author rejects Richter's idea of sapping just above the level of the névé, because it would produce a broad shelf, which has not been discovered; but he accepts Johnson's theory, though this method would also produce a shelf at a level only 150 or 200 feet lower. He has, however, presented convincing evidence to show that the cirque is enlarged by sapping and that the forms with which we are familiar in glaciated mountains are the result of the extension of cirques by glacier erosion.

There are many ways of classifying glaciers, according to the characteristics one desires to emphasize. The author classifies glaciers in accordance with the amount of alimentation, and brings out some interesting relationships of the different forms; but it seems that, in this matter, he has not put sufficient emphasis upon underlying topography.

The accounts of the Arctics and the Antarctics are particularly interesting; the author has evidently studied the reports of all the explorers and has brought them together in a very readable form and in such a way as to give an excellent general survey of those distant regions. He insists that there are very marked fundamental differences between the character of alimentation in the polar regions and in temperate zones. In the latter, the precipitation is due to moist winds being raised to cold altitudes by the mountains themselves and then precipitating their moisture in the form of snow. In the polar regions Professor Hobbs thinks that there are no surface air currents blowing across the great ice masses from the adjacent seas. It has been made out that over Greenland and over the Antarctics there are great regions of high barometer; and the reports of explorers show that they almost invariably encountered winds blowing off the surface of the ice, and when these winds attained a fair strength they carried with them many fine particles of snow which were swept along for considerable distances. These outward air currents Professor Hobbs ascribes to the cooling and consequently increased density of the air by contact with the cold surfaces, followed by the air sliding off the great ice cap in all directions. This, of course, requires that the return currents should flow in at a higher altitude, and sink down upon the ice from above. These currents, which bring but little moisture, are heated dynamically as they sink, melting and evaporating whatever ice spicules they may be carrying, and the vapor is again frozen as it approaches the ice surface. In this way he accounts for the falling snows under clear

skies, which have been described by Arctic explorers. In the Arctics there is always a fringe around the ice masses where the winter's snow is all melted during the summer. In the Antarctics this is not the case, as the snow line extends quite to the sea level. The discussion of the various forms of ice masses and the formation and appearance of icebergs is most interesting. Glacialists will find much to interest them in this book and also many explanations with which they will not agree. For instance, the author thinks that the alimentation of the Arctic ice occurs largely at its borders and is due to the snow being driven off the ice cap by the wind and piling up, around the edges, forming a convex surface, like a sand dune; it is hard to reconcile this with retreating glaciation. Also, the figure on page 139 would hardly have been inserted if the author had carefully considered the lines of flow of glacier ice.

The book is profusely illustrated and the illustrations elucidate the text; every one of them is referred to and they make the descriptions very vivid without the use of too many words. The reproduction, on the same scale, of plans of a number of glaciers, in plate 11, and Fig. 134, is very instructive. The numerous references at the end of every chapter will be very acceptable to those who desire to consult the original articles.

Harry Fielding Reid

Fortschritte der Mineralogie, Kristallographie und Petrographie, herausgegeben im Auftrag der Deutschen Mineralogischen Gesellschaft, von Dr. G. Linck, Jena. Gustav Fischer, Jena, 1911. Pp. 290.

The German Mineralogical Society has undertaken to publish annually a report of progress in various fields of investigation related to mineralogy. This interesting first volume gives promise of a successful series. Dr. Linck is editor in virtue of his office as secretary of the society; the authors of the papers are specialists in their various fields and the presentation is intended to be popular. The varied subject matter shows how wide is the field to be covered. There are twelve reports as follows. H. Baumhauer (Freiburg) treats of the Law of Complication and the Development of Crystal Faces in Complex Zones, accepting and elaborating Goldschmidt's work (17 pp.); O. Mügge (Göttingen), On the Twin Structures of Crystals (30 pp.), and F. Becke (Vienna), On the Formation of Twin Crystals (18 pp.), discuss very fully modern points of view as to definition and development of twinning; A. Ritzel (Jena) treats of the recent literature on Velocity of Crystal Growth and Solution (13 pp.). Under the heading Mineralogy, R. Marc (Jena) summarizes the literature on the Phase Rule and its Application to Mineralogical Questions (30 pp.); R. Brauns (Bonn) deals with the Causes of the Color of Faintly Colored Minerals and the Effect of Radium Rays upon the Color (12 pp.); A. Bergeat (Königsberg), reviewing the Genetic Interpretation of the North- and Middle Swedish Iron-ore Deposits in Recent Literature (18 pp.), shows the modern tendency towards regarding them as of magmatic origin; A. Schwantke (Marburg) gives a descriptive list of new minerals which have been described since 1898, arranged alphabetically without references to literature (20 pp.). Under the heading Petrography, F. Rinne (Leipzig), on Saltpetrography and Metallography in the Service of the Study of Eruptive Rocks (37 pp.), shows the bearing of such physico-chemical investigations as those of van't Hoff on the Stassfurt salt deposits upon the interpretation of processes of crystallization in igneous magmas; F. Becke (Vienna), in Advances in the Province of Metamorphism (36 pp.), reviews 87 papers which have dealt with this subject in the past three years. Under Meteorites, F. Berwerth (Vienna), Advances in the Knowledge of Meteorites since 1900 (28 pp.), gives a complete bibliography of 394 entries, covering what has appeared on meteorites since the publication of Wülfing's book, together with critical reviews of many papers. Lastly H. E. Boeke (Halle) gives a brief account of the work of van't Hoff, especially as it bears upon mineralogy and geology.

The book is sent free to members of the society and is also on sale through dealers.

C. PALACHE

Nature Sketches in Temperate America. By JOSEPH LANE HANCOCK. Chicago: A. C. McClurg & Co. 1911. Pp. xvii + 451, 12 col. pls., 215 figs.

The preface of this attractive book says that it is a "popular exposition of the facts gleaned from nature" which often presents the subject "from the artistic or æsthetic point of view. This method does not sacrifice truth, which is the religion of science, but mitigates it, bringing about a wider reading circle. . . . More consideration is given to insects than to other groups of animals" and "the relation of animals and plants to their natural surroundings has been kept constantly in mind." The bearing of the subject matter on the theory of evolution is also considered in some detail.

Chapter 1 is devoted to "Evolution and Natural Selection." It gives a brief but complete discussion of the most generally accepted ideas concerning evolution and heredity with a few notes concerning their bearing on the subjects under consideration. Chapter 2 takes up "Adaptations in Plants and Animals, with Examples" and presents some interesting cases of particular adaptations—such as: how the milkweed profits by the visits of its insect guests; bird flowers; and the seasonal procession of flowers, insects and birds. Chapter 3 begins with a brief discussion of the theories of protective resemblance; the tree toad is next described, and the writer then takes up the walking-stick and various other insects and insect larvæ that are protected by their form, color or behavior. Chapter 4 is devoted to mimicry, and after discussing Bates's, Müller's and other theories, describes the monarch and viceroy butterflies, a bumble-bee and a robber-fly, and flower-frequenting flies. Chapter 5 takes up Wallace's theory of warning colors and then passes to a consideration of several bright colored lepidoptera and lepidopterous larvæ. Under the title "Animal Behavior, with Examples," Chapter 6 is opened with a brief statement of the author's ideas on instinct and intelligence and a table showing the distribution of sense organs in insects; then follow brief descriptions of the habits of many insects, spiders and birds. Chapter 7 is devoted to "General Observations and Sketches Afield." It considers: the formulation of problems, origin by adaptation in nature, ponds, brooks, meadows, the bumble-bees' night camp, etc. The title of Chapter 8 is "Ecology—Interpretation of Environment as Exemplified in the Orthoptera." In it are discussed the sources of life after glaciation, habitats of plants and animals, zoogeography, nature's reclamation of sterile ground, and various things concerning a number of Orthoptera. The last chapter consists of two parts: (1) a "classified list of habits of various species of Orthoptera based on their egg-laying sites, to show their relation to plant formations in general" (which follows the classifications used by some plant ecologists) and (2) "definitions of common environmental complexes, grouped under formations," in which seventy-six terms (including ocean, sea, lake, pond, pool, stagnant water, snow, alkali, sterile and man's houses) are defined.

The book contains many interesting descriptions of the habits of animals. Among the best of these the parts of chapters on the habits of the walking-stick, the castle-building spider, the golden Sphex as the grasshopper's enemy and the habits of the green meadow grasshopper, may be mentioned. An excellent picture is presented of the life of the animals discussed. The colored plates are excellent, and the same is true of many of the photographic plate illustrations, but some of the latter are so dark that they fail to show the points they are intended to demonstrate.

Hancock presents the theories of natural selection, mimicry and warning coloration in a rather dogmatic fashion and follows them with examples which have not always been indubitably proven to have been brought about in the way he intimates. A reader unfamiliar with the field might easily believe that these dogmas had never been disputed,

for the theories and examples are presented with little comment and the writer is "satisfied to let the reader draw his own conclusions." With what Hancock gives, the reader would doubtless conclude that everything was readily explained by the theories presented—though by this method the theories have the advantage of being clearly and definitely formulated. The reader is rather disappointed when he finds that the hundred-page chapter headed "Ecology—Interpretation of Environment as Exemplified in the Orthoptera" consists mostly of short descriptions of the habits of grasshoppers, and he looks in vain for the "interpretation."

The general reader will probably be confused where such terms as lores, calamus, rachis, vanes, barbs, barbules (p. 46) and luna (p. 60) are introduced without explanation. There is frequent and somewhat monotonous allusion to a "plate photographic illustration" which is often several pages from the reference. The reader would have been saved much time by a page reference. At the top of page 384 reference is made to a plate that appeared in the *American Naturalist* in 1905 but does not appear in the book! Among other loose and careless statements, such as are likely to appear in any first edition, the following may be mentioned: Humming birds are said to occur "in the tropics" and they are found only in America (p. 43). On pages 73 and 75 "this species" is discussed when no species has been mentioned; on page 86 the pronoun "them" refers to "substance." The following sentence occurs on page 299: "The cherries were luciously ripe, and after eating a few, one is apt to feel a dislike for their pungent flavor." "Geophilous" is used to designate animals that feed on the surface of the ground (p. 356), and one wonders how an animal like the earthworm, that eats dirt, would be classified. These *definitions* are given (pp. 432 and 433): "Desert: Vast sandy tracts of land, appearing in western United States, where evaporation exceeds rainfall. . . . Man's Houses: Country and City Houses; (*a*) basement; (*b*) upper floor." *Rana catesbiana* appears on page 300 as *R. catisbiana* and on the plate facing this page as *R. catisbiani.* It is difficult to understand the writer's meaning when (p. 356), after stating that short-winged acridians are less numerous in treeless, arid districts than in humid, forested regions and that most flightless species of locusts are plant-feeding as distinguished from ground-feeding, he says: "My own conclusions . . . is simply this: that it is a question of food supply and nutrition derived therefrom. In the case of short-winged forms, they are due to under-development as the result of scant food."

A. S. PEARSE

SPECIAL ARTICLES

ON POWERS OF TEN

FOR expressing numerically the widely varying magnitudes occurring in scientific work, two methods are in common use. Both are adequate and accurate, but results expressed by means of one are much more easily grasped and remembered than with the other. The more convenient method appears to be gaining in use. The present paper is written with the idea that this desirable change may be accelerated if the advantages of the method are stated, and thus presented to those who have hitherto not given the matter special attention.

The simplest way of writing a number is, of course, to write it out in Arabic notation. But this, in general, involves the presence of numerous ciphers, which the reader must count in order to learn what the number is. There is, therefore, a gain if the writer counts the ciphers for him and records the number obtained. Hence the familiar system, where a number is given as the product of (1) a series of significant digits, and (2) ten, with an exponent (*e. g.*, the velocity of light is 3×10^{10} cm. per sec.).

This system has still one great disadvantage: it calls in each case for the reading of two numbers, and thus greatly increases the strain on both the attention and the memory. And this difficulty is multiplied when the

quantity expressed is less than unity, as it is about half the time. For then the exponent is negative, and the two numbers affect the resultant magnitude in opposite ways.

For instance, suppose a galvanometer which requires 3×10^{-8} amperes to give unit deflections: how will its sensitiveness compare with that of one for which both indicating numbers are numerically larger, say, 8.0×10^{-9} amperes? The larger significant figure, 8.0, indicates a larger current, and therefore less sensitiveness, but the exponent, 9, though also larger, indicates greater sensitiveness. Really, the second is about four times as sensitive as the first, but this fact is far from evident on a first reading; yet this is a very simple case. If a reader should see an account of one of these instruments on a Friday, and of the other on, say, the next Wednesday, it would require unusually careful reading indeed to leave him with any definite idea of the relative sensitiveness.

The difficulty of this system can also be well stated as follows: When a number of magnitudes, say diameters of small rods, is stated, sometimes in centimeters and sometimes in millimeters, it is evident that a good deal of unnecessary difficulty results, which can be avoided by sticking to one unit or the other. Now, between a millimeter and a centimeter there is the same difference as between any two consecutive powers of ten. An unrestricted system of notation by powers of ten, therefore, amounts practically to an unnecessary multiplication of the number of working units.

The remedy is obvious—to diminish the number of units. This is realized in the other system, which proceeds by steps of 1,000, instead of 10. A further gain is sometimes secured by using prefixes instead of exponents to indicate the working units, since the combination of a word and a number is preferable to two numbers, each of which interferes with the apprehension of the other, and even more with its recollection. This system is perhaps seen at its best in the field of electricity, where, besides the units, ampere, ohm, volt, etc., the milliampere, millivolt, microampere, microvolt, kilowatt, megohm, etc., are in common use, and have almost completely displaced the reckoning by powers of ten. The advantages of the system have been made available in stating galvanometer sensitiveness by the scheme proposed by Ayrton. The sensitiveness is simply put equal to the deflection produced by a unit current, usually the microampere. According to this scheme, the sensitiveness of one of the galvanometers mentioned above is 125, of the other, 33. Here the difficulty of remembering or comparing the two quantities would seem to be reduced to the minimum. And this illustration gives a fair idea of the value of the general method. Under it, but one thing claims attention: a single number, which need never exceed 3 digits unless the accuracy attained calls for a larger number of significant figures. Such a number is relatively easy to comprehend and to remember. The unit needs almost no attention, since all magnitudes between which a comparison is likely to be desirable will be expressed either in the same unit, or else in units so far apart that no confusion will occur.

This choice of units is, of course, the essential part of the method, and it, of course, can be realized under the form of the notation by powers of ten by those to whom that form seems desirable. All that is necessary is that those powers of ten shall be chosen which are also powers of 1,000, so that the use of 10^2, 10^4, 10^5, 10^7, 10^{-2}, etc., is to be discontinued. But the use of the prefixes to denote the units seems decidedly preferable. The electrician who should be advised to abandon his microvolts and milliamperes, and go back to "volts $\times 10^{-6}$," etc., would scarcely be profoundly impressed with the value of the advice.

A few special points seem worth noticing in this connection.

A single prefix to denote 10^{-9} seems desirable. Until it appears, 10^{-9} amperes (for instance) should of course be called a millimicroampere. "Micro-micro," of course, means a millionth of a millionth, or 10^{-12}, and is illogical when used for 10^{-9}, besides

being less euphonious than the other. But it may be too late to stop the illogical use of $\mu\mu$ for the millimicron ($m\mu$) in the domain of optics.

There will undoubtedly be a tendency, as reckoning by powers of 1,000 comes more into use, for work in each particular line to be always expressed in the same derived unit. Here the advantage of a common unit more than compensates for the fact that in some particular cases the unit is not quite the most convenient. For instance, workers with thermoelements have generally found it advantageous to work in microvolts, and to keep to this unit even when the number of microvolts is over 10,000, that is, more than 10 millivolts.

In case of doubt between two units, it is probably better to use the smaller. For this diminishes the use of fractions, and also gives records more likely to be concordant with future work, since the increase of accuracy as time goes on increases the advantage of the lower unit.

In no class of quantities is more to be gained by reckoning by powers of 1,000 than with coefficients of expansion, and temperature and pressure coefficients generally. If these quantities were always tabulated in thousandths or millionths, instead of with a variable number of zeros, according to the fancy or convenience of the tabulator, a very much larger number of them would actually lie in the memory of the average working experimenter than are now to be found there. Yet these quantities, and some others, being pure numbers, have no special name, and therefore nothing to which the prefixes, milli-, micro-, etc., can be attached. They may legitimately be designated as "parts per mille," "parts per million," etc., but these expressions are rather awkward, particularly when the whole expression is "parts per mille per degree," or something like that. It would be convenient to use the fractional prefixes alone as nouns in such cases, milli meaning one part per thousand, and micro, one part per million. There is certainly considerable reason to wish that some leader, or committee, having sufficient authority, would authorize the use in this way of these terms (or something better). They have these advantages: They are brief; they would harmonize with the terms used for other physical quantities; they would tend to extend the use of powers of 1,000. For instance, at present, most observers, working to an accuracy of (say) 10 parts per million, would prefer to state it as one part per 100,000, while with the word "micro" in use the almost universal expression would be 10 micros. And the use of powers of 1,000 is quite as desirable in stating errors, etc., as in most other cases.

The use of fractional or multiple prefixes also sounds a little strange in those cases where, in order to adhere strictly to the C.G.S. system, the centimeter is used as the unit of all linear measurements. The real difficulty here, however, does not lie in the prefixes, but in the fact that two different fundamental units, the meter and centimeter, are in use, and that most physicists are probably more used to measuring small lengths in millimeters and microns. This difficulty would not be increased by the use of the term millicentimeter and microcentimeter, which are of course the logical terms to use if the centimeter is to become the practical unit of all lengths. It also seems logical to use the centimeter only where such other C.G.S. units as the absolute electrostatic and electromagnetic units would be used, and to use the millimeter and micron in cases corresponding to those where the ampere, ohm and volt would be considered appropriate.

In any case, it may be well to repeat, the main and essential advantage of the newer system that is coming into use is in the restriction of notation to powers of ten which are also powers of 1,000. And this restriction can profitably be adopted whatever may be thought or done regarding the other points mentioned in this paper.

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